The magazine for Sinclair users and Timex/Sinclair users $2.95

SYNC®

November/December 1983 Volume 3, Number 6

SYNC AT THE CONCERT: MUSIC AND SOUND

Speech PRINTing • ZON Music Making • Staff Learning • DEFMAG–Synthesizing Sound • AUDISY–Digitizing Sound • MACHINE LANGUAGE: ROM Calls • Linear Search • DIRECTORIES: User Groups • Newsletters • REVIEWS: ZON X-81 • Fantastic Music Machine • Virtuoso • Aerco Disk System • TS2040 Printer

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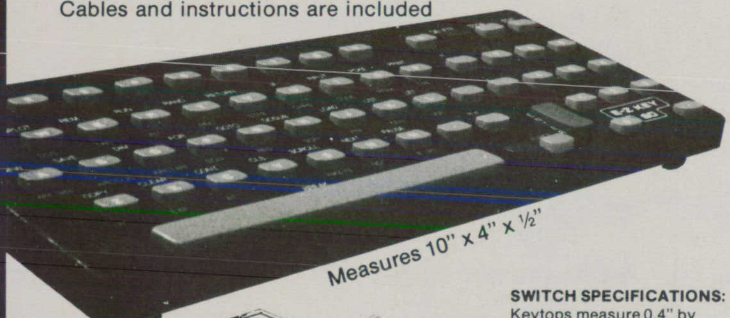

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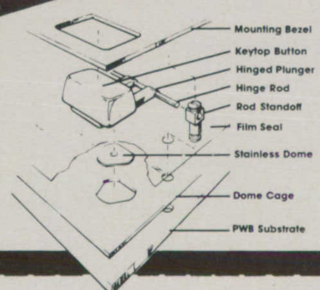

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SYNC®

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Cover by **Bob Aiese**

letters

Adding a Joystick

Dear Editor:

James Stephens' "Adding a Joystick" (*SYNC* 3:4) begs an additional hardware improvement for greater versatility by making it operable in both normal (Atari VCS) and modified (TS1000) modes. Simply add an SPDT toggle switch.

Instead of soldering the center lead to KB4 directly as indicated in Figure 1, route it to the middle contact of the toggle switch. Then connect the remaining two switch contacts to the joystick edge traces KB4 and D3. Mount the switch assembly in a desirable location, e.g., ream a hole in the case (be careful not to damage the computer insides). You now have a switch selectable joystick.

Mike Lagodmos
7035 Grovespring Dr.
R.P.V., CA 90274

Dear Editor:

To get 8 directions on the Atari joystick (*SYNC* 3:4), enter these lines:

```
10 LET A=(INT SQR (PEEK 16421*
PEEK 16422))
20 PRINT A
30 PAUSE 120
40 GOTO 10
```

Then move the joystick to each of the 8 positions plus the fire button. Write down each code that is printed and use it in the new cursor control code.

The variable Last K located at 16421 is a two byte variable, and line 10 will produce a one byte value for each position of the joystick. It is an arbitrary value that simulates half a decode of the keyboard and will work well.

The Basic program in Listing 1 in the article will produce an unexpected reverse motion of the cursor in the X axis as lines 70 and 76, 145 and 150 have the + and - values reversed.

Ed Hostetler
30224 Westlawn Dr.
Bay Village, OH 44140

Making Backups for ML Tapes

Dear Editor:

Jack Ryan's article "Making Backups for Machine Language Tapes" (*SYNC* 3:1) tells how to PEEK into the code of ML programs stored above RAMTOP and store that code into the array of a Basic program which is then SAVEd to tape. To reload the ML program, you must lower RAMTOP to its required location, and then LOAD and run the Basic program. This reverses the process by POKEing the code back into its original location.

Readers who have trouble LOADing some ML programs backed up this way may have one of these problems:

1) You may have to set the GOSUB stack as well as RAMTOP to a lower location. In this case, press NEW after POKEing in the required lower value of RAMTOP. This executes the ZX/TS initialization routine which relocates the GOSUB stack and the machine stack to just below the current (lower) value of RAMTOP. Then LOAD and RUN the Basic program.

2) You may have a shortage of memory (report code 4). The program in the article will back up ML programs up to about 2.3K long when using a 16K RAM. If you run out of storage, try making these changes in the Basic program:

```
270 DIM E$(C)
290 LET E$(N)=CHR$ PEEK (D+N)
340 POKE (D+N),CODE E$(N)
```

Storing the code in a character array instead of a numeric array allows you to back up ML programs three times as long.

Ed Shaughnessy
151 Daniel Low Terr.
Staten Island, NY 10301

Hardware Problems

Dear Editor:

I purchased my ZX81 when it first came out and, after installing a new power plug and a flexible cable to the RAM, I finally decided to stop playing with it. I rubbed mercury on the edge connector. Since mercury does not sustain corrosion, I have not had any trouble since. My ZX81 stays on 24 hours a day, 7 days a week when I am working on it.

I have not had any LOADing problems since I realized that new tape recorders could come with dirty heads.

Paul J. Beatty
7634 N. Greenview
Chicago, IL 60626

Dear Editor:

After adding a keyboard and a 32K RAM to my TS1000, I have had problems with my keyboard dumping out my programs.

I solved this problem by replacing the keyboard diodes with a buffer amp (74LS244). I used a 20 pin wirewrap socket with the legs bent to fit. Enable lines, pins 1 and 19, are tied to ground and the outputs of the buffer amp go to the keyboard.

My solution for RAM pack wobble was a 48 conductor ribbon cable soldered directly to the motherboard.

Raymond E. Townsend
2233 E. 8th St., Sp 294
Pueblo, CO 81001

Help

Dear Editor:

I am searching for a program which will find the inverse of a matrix. As an engineering student, I have many occasions to use such a program. Is there anyone who sells such a program?

Michael L. Miller
721 E. Buerkin
Peoria, IL 61603

Glitchoidz Report

Machine Code and Your TV Screen 3:4.

Figure 1 will work as described without a 16K RAM pack. If you use the 16K, the screen is automatically filled up with spaces. Thus an "empty" line consists not of just the character 118 (the "enter" character), but of 32 spaces (character 0) followed by the "enter" character.

Figures 3 and 4:
70 IF A<64 THEN GOTO 50

Figure 7:
120 GOTO 20

For those especially desperate for a machine code translation of Figure 7, see Figure 1.

Payroll 3:5, p. 4.

Change:
978 IF M$="Z" THEN GOTO 975

PCB Differences 3:5

P. 4, col. 2, 1st par.
AB-A15 should be A8-A15.

Figure 1.

Basic Line number	Machine Code	Label	Mnemonics
20	237, 91, 12, 64	TWENTY:	LD DE, (16396)
30	33, 20, 0		LD HL, 20
40	25		ADD HL, DE
50	126	FIFTY:	LD A, (HL)
60	60		INC A
70	254, 38		CP 38
	56, 5		JR C, ONE-TEN
80	54, 28		LD (HL), 28
90	43		DEC HL
100	24, -11		JR FIFTY
110	119	ONE-TEN:	LD (HL), A
120	24, -22		JR TWENTY

The Logical Operators 3:5

P. 77, col. 3, last line:
(.9 OR P>=100)

Brick Buster 3:5

The game worked for us with the code as printed in Figure 2. However, reader Carl S. Lucas, Jr., found it necessary to change the code at 40E4 from DB04 to DBFE in order to make the paddle move. This change also worked for us.

Line notes:
120: A (30)
190: Space (31)

Extensions to Basic 3:5

Figure 1.
500 REM ABE,IKE,

Listings 4-8: Omit lines 1-5 in each.

The next to last paragraph of the article should begin: "You can plot..."

The author reports a minor bug that sometimes causes data to be misread. To correct the bug, type the programs as instructed in the article if you have not already done so. LOAD Listing 2 from tape, but do not press ENTER. Instead press EDIT, STOP, and then ENTER. Next type in:

POKE 16525,6
POKE 16533,32
RUN

SAVE Listing 2 back to tape.

sync notes

Paul Grosjean

SYNC at the Concert

Our theme section this issue is "SYNC at the Concert" with a focus on sound applications. While we have articles on music and articles on speech, we had no articles (or proposals even) for putting the two together to make the computer sing! We hope that the music capabilities of the computer (along with the software and hardware) open up new fun and creative opportunities for you whether you are a musician or not. The speech applications of computer technology offer some exciting possibilities for the speech and hearing impaired.

In volume 1 of *SYNC* we published two articles on using the ZX80 for making music. "Robot Composer" by Cecil Bridges and "Making Music with the ZX80" by Richard Forsen. Both articles give programs and directions for using the computer to make music. These articles, with translations for the ZX81/TS1000 are both included in *The Best of SYNC,* vol. 1.

Next Issue

Our theme section next time will look again at home and office applications—keyboards, printers, word processing and tax packages.

Timex/Sinclair Celebration

The Sinclair-Timex User Group of the Boston Computer Society is sponsoring a Timex/Sinclair Celebration in honor of its second anniversary on Saturday, October 22, from 10 a.m. to 6 p.m. at the Boston Park Plaza Hotel in downtown Boston.

This event will not only recognize the achievements and accomplishments of the various user group members, but also will demonstrate how the TS1000 series computers can be used in everyday life, e.g., business, home, education, and entertainment. The group guarantees that you will leave at the end of the day with some concrete ideas of what can be done with the "inexpensive" TS computers.

Vendors from all over the country will demonstrate and sell products compatible with the TS computers, e.g., software, hardware, publications, and services. In addition, Manufacturers Marketplace, a local Timex retailer, plans to be selling TS computer systems, including the new TS1500 and TS2068, subject to availability, as well as the full line of TS software.

There will be workshops and seminars given by BCS user group members, vendors, and Boston educators, to name a few.

For further details,contact the Boston Computer Society, 3 Center Plaza, Boston, MA 02114, (617) 367-8080.

ZX Microdrive

Sinclair's ZX Microdrive for the Spectrum was introduced in the U.K. in mid-summer. The Microdrive, based on a Sinclair designed, Ferranti custom-built chip, will store a minimum of 85K on removable magnetic cartridges. A typical 48K program can be loaded in as little as 3.5 seconds. The drive is powered by the Spectrum's power supply.

A FORMAT command initializes the cartridge. The CAT command enables the contents to be read and displays the cartridge name, up to 50 files in alphabetical order, and the free space in kilobytes.

The controller is the ZX Interface 1. This multi-purpose unit can support up to eight Microdrives for a total of 680K. It also incorporates an RS232 interface which will permit linking the Spectrum to other computers, e.g., a local area network can link up to 64 Spectrums (transmitting at 100Kbaud); drive other peripherals, e.g., full-size printers; and transmit data over telephone lines with a modem.

Sinclair is encouraging widespread development of Microdrive application software by supplying Microdrives and blank cartridges in bulk to the leading independent software houses.

Read This First

Before you enter the programs in this issue, please note:

All the programs require the **8K ROM** and **16K RAM** unless other requirements are given at the top of the first page of the article.

Read the article all the way through before trying to enter the program.

A letter after a number shows the type: b for binary; d for decimal; h for hexadecimal.

In PRINT statements:

#: Enter a necessary space.

A (32): The underline means use the graphic on that key. The number in ( ) tells how many times.

$\overline{A}$: The overline means use the key in inverse.

INPUT: An underlined *word* found on the keyboard should not be spelled out. Enter it directly. If it will not ENTER, hit THEN, then the keyword you want, backspace, delete THEN, and continue entering the line. This memory saving technique may be disregarded if you have enough RAM.

just for fun

"Just for Fun" shares short programs that illustrate a point, demonstrate a technique, or show something the author has found interesting. If you have some programs that you want to share, send them to: Just for Fun, SYNC, 39 E. Hanover Ave., Morris Plains, NJ 07950.

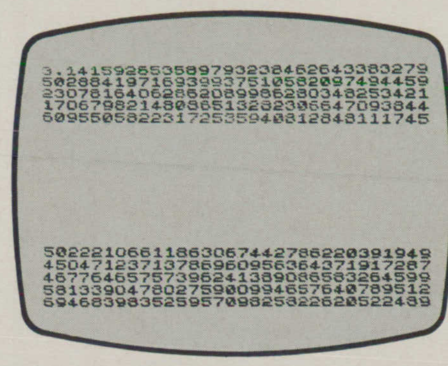
Lots of Pi

Blanchard Smith

8K ROM; 16K RAM

This program computes the value of Pi to 8, 16, 32, . . . up to 8192 decimal places! It uses base-100 arithmetic rather than decimal arithmetic and puts the numbers in character strings rather than arrays of five-byte numbers. It uses long-division to get the terms of Taylor's series expansion of the arctangent, and long-addition to get the algebraic sum until the term vanishes.

But do not wait with baited breath for the answer. It takes about 60 hours (FAST mode, naturally) to compute Pi to 2048 decimal places! If you do not have a printer, modify the subroutine at 6000 to PRINT a page and STOP before continuing.



Blanchard D. Smith, 2509 Ryegate Ln., Alexandria, VA 22308.

```
  10 REM  PI TO 4,8,16,,,8192
DECIMAL PLACES
  20 LET T=100
  30 FOR J=2 TO 12
  40 LET N=2**J+1
  50 DIM A$(3,N)
  60 LET A$(1)=""
  70 LET A$(2)=""
  80 LET A$(2,1)=CHR$ 16
  90 LET D=5
 100 GOSUB 4700
 110 LET S=1
 120 LET D=25
 130 FOR E=1 TO 9E9 STEP 2
 140 GOSUB 5000
 150 GOSUB 4700
 160 LET S=-S
 170 IF Z<>0 THEN NEXT E
 180 LET A$(2)=""
 190 LET A$(2,1)=CHR$ 4
 200 LET D=239
 210 GOSUB 4700
 220 LET S=-1
 230 FOR E=1 TO 9E9 STEP 2
 240 GOSUB 5000
 250 GOSUB 4700
 260 LET S=-S
 270 GOSUB 4700
 280 IF Z<>0 THEN NEXT E
 290 GOSUB 6000
 300 NEXT J
 310 STOP
 320 CLEAR
 330 LET X$="PI"
 340 SAVE X$
 350 RUN
4700 LET A=0
4710 LET Z=0
4720 FOR K=1 TO N
4730 LET A=CODE A$(2,K)+A
4740 LET Q=INT (A/D)
4750 LET A$(2,K)=CHR$ Q
4760 LET R=A-D*Q
4770 LET A=R*T
4780 LET Z=Z OR (Q+R)
4790 NEXT K
4800 RETURN
5000 LET A=0
5100 FOR K=1 TO N
5110 LET A=CODE A$(2,K)+A
5120 LET Q=INT (A/E)
5130 LET A$(3,K)=CHR$ Q
5140 LET A=(A-E*Q)*T
5150 NEXT K
5160 LET C=0
5170 IF S<0 THEN GOTO 5240
5180 FOR K=N TO 1 STEP -1
5190 LET A=CODE A$(1,K)+CODE A$(
3,K)+C
5200 LET C=A>=T
5210 LET A$(1,K)=CHR$ (A-(T AND
C))
5220 NEXT K
5230 RETURN
5240 FOR K=N TO 1 STEP -1
5250 LET A=CODE A$(1,K)-CODE A$(
3,K)-C
5260 LET C=A<0
5270 LET A$(1,K)=CHR$ (A+(T AND
C))
5280 NEXT K
5290 RETURN
6000 LPRINT ,," "
6010 LET P$="3."
6020 FOR K=2 TO N-1
6030 LET X$="0"+STR$ CODE A$(1,K
)
6040 LET P$=P$+X$(LEN X$-1 TO )
6060 IF LEN P$<32 THEN NEXT K
6070 LPRINT P$
6080 LET P$=""
6090 NEXT K
6100 RETURN
```

Explanation???

Robert J. Midura

8K ROM; 1K RAM

Type in the following lines:

```
  4 REM (OPTIONAL) PRINT
  5 LIST 10
 10 FOR L=0 TO -1 STEP 100
 20 STOP
 30 NEXT L
 40 PRINT AT 3,29;L
 50 NEXT L
 60 PRINT AT 5,29;L
 70 NEXT L
 80 PRINT AT 7,29;L
 90 LET L=L*4
100 PRINT AT 9,29;L
110 NEXT L
120 PRINT AT 11,29;L
130 LET L=-1
140 PRINT AT 13,29;L
150 NEXT L
160 PRINT AT 15,29;L
170 LET L=-101
180 NEXT L
190 REM     **** NOTE ERROR 9/20
```

For best results use SLOW mode. Press RUN and ENTER. Observe the results. How does this one work?

Robert J. Midura, 19 Merrifield St., Worcester, MA 01605.

Richochet Revisited

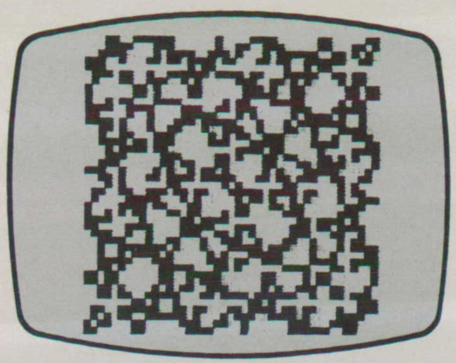
David R. Rowland

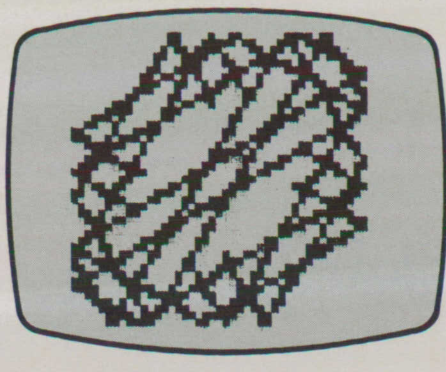
8K ROM; 1K RAM

One of the pleasures of the "Just for Fun" column comes from typing in the program, playing around with it, and coming up with something new or different. This particular program started out as

David R. Rowland, 97 Essex Ave., Montclair, NJ 07042.

```
  6 LET E=RND*4-2
  7 LET M=RND*4-2
  8 LET X=RND*42
  9 LET Y=RND*42
 10 PLOT X+10,Y
 11 PLOT Y+10,X
 12 PLOT 52-X,42-Y
 13 PLOT 52-Y,42-X
 14 LET Y=Y+M
 15 LET X=X+E
 16 IF X<0 THEN LET X=0
 17 IF Y<0 THEN LET Y=0
 18 IF X>42 THEN LET X=42
 19 IF Y>42 THEN LET Y=42
 20 IF X=0 OR X=42 THEN LET E=-
E
 21 IF Y=0 OR Y=42 THEN LET M=-
M
 22 GOTO 10
```





James John Hollandsworth's "Richochet" (*SYNC* 3:2) and evolved into something rather different with only a few changes. Run in SLOW mode. Be patient. If the first pattern does not please, try again.

INPUT Anywhere

Matt Dralle

8K ROM; 1K RAM

If you have ever wanted to INPUT variables from somewhere other than the bottom left hand corner of the screen, "INPUT Anywhere" is the answer.

The program allows any number between 0 and 9999 to be INPUTted anywhere on the screen. Negative numbers cannot be used.

To change the INPUT location, change the PRINT AT statements in lines 15 and 40. Be certain that the Y coordinate in line 15 is one less than that of line 40. When INPUTting numbers less than 1000, be sure to add preceding zeros, e.g., 0020, not 20.

The ENTER key need not be pressed after the number is typed in. On the last keystroke, the entire number automatically goes into variable A, and the program continues.

Matt Dralle, 2937 Layton Dr., Davis, CA 95616.

```
  5 LET A$=""
 10 FOR I=1 TO 4
 15 PRINT AT 10,9+I;"■"
 20 LET U$=INKEY$
 25 IF U$="" THEN GOTO 20
 30 LET A$=A$+U$
 40 PRINT AT 10,10;A$
 50 NEXT I
 60 LET A=(CODE A$-28)*1000
 70 LET A=A+(CODE A$(2)-28)*100
 80 LET A=A+(CODE A$(3)-28)*10
 90 LET A=A+CODE A$(4)-28
100 PRINT A
```

COPYing Lines 23 and 24

William H. Baldwin

When I got my TS2040 printer, I found that it would COPY the top 22 lines of the display. Quite a few programs use the bottom two lines, yet these are not available to the printer by the COPY command.

All 24 lines can be COPYed with the short machine code routine below. Type in the following line:

```
1 REM -/LN ?▒TAN
```

Type in the immediate mode

POKE 16517,107

Then any where in the program that you want to COPY the screen, add the following line preceded by the appropriate line number:

(line number) RAND USR 16514

This line should come immediately after the screen looks like you want it to on paper. Voila! All 24 lines of the display!

William H. Baldwin, 6016 W. 87 Terr., Overland Pk., KS 66207.

kitchen sync

Alan Groupe

Turning Tables on the Bank

After a short vacation changing jobs, being confronted with a company-wide layoff at my new job, leaving after only three months for my current job, and becoming engaged to a girl who thinks microbiology is fun, I returned to the important things in life—home computers.

Like the traditional young couple in suburbia, my financee and I are looking to buy a house. But calculating mortgage rates and monthly payments is an awful pain. Luckily, affordable calculators have recently become available that will do these calculations. But if you do not mind sacrificing portability, your ZX81/TS1000 will do an admirable job.

A mortgage is simply an annuity, only backwards—somewhat. An annuity is a lump sum of money, earning interest at some rate, which is being drawn upon at a regular rate, until it is used up. In the general case, you would deposit some amount of money into a bank account and make equal monthly withdrawals until the account was empty.

The four components of an annuity are the payment, present value, interest rate, and number of payments. Most business calculators will compute any of the four, given the other three. (There is a fifth component, called the future value, but it is of no interest in calculating mortgages.)

The *payment* is the amount of the regular withdrawal from the annuity. In the case of a mortgage, it is the amount of the monthly mortgage payment. Most business calculators have a key marked "PMT" for this value.

The *present value* of an annuity is its initial amount. In other words, the amount you initially deposited in the bank, or the amount that you borrowed from the bank, in the case of a mortgage. Most business calculators have a key marked "PV" for this value.

The *interest rate* is the periodic interest rate for the period between payments. For a 12% APR (annual percentage rate) mortgage, this interest rate would be 0.12 *only* if mortgage payments were being made annually. In general, mortgage payments are made monthly and the interest rate is therefore divided by 12. Most business calculators have a key marked "i" for the interest rate.

The *number of periods* is simply the number of withdrawals that can be made, or the number of mortgage payments that must be made, before the annuity is used up. Most business calculators have a key marked "n" for this value.

Since single letter variable names tend to work better with tiny computers, I have chosen to use the single letter "P" to represent the payment ("PMT") and the single letter "V" to represent the present value ("PV"). The interest rate and number of payments will remain "I" and "N", respectively.

Opening up my college accounting textbook (I had to open it eventually) we see that the present value, V, of an annuity is given by the formula.

$$V = \frac{P}{I}\left[1 - \frac{1}{(1+I)^N}\right]$$

or, in Basic syntax:

V=(P/I)*(1-(1/(1+I)**N)

A little algebraic manipulation gives us the comparable formula for the amount of the payment, P:

P=(V*I)/(1/(1+I)**N)

Isolating N on one side of the equation gives us:

V*I/P=1-(1/(I+I)**N)

1/(1+I)**N=1-V*I/P=(P-V*I)/P/P

(1+I)**N=P/(P-V*I)

Now we take the logarithm of each side of the equation (bet you never thought you'd actually have a use for the "LN" function):

N*LN(1+I)=LN(P/(P-V*I))

And finally, the equation for the number of payments:

N=LN(P/(P-V*I))/LN(1+I)

According to my future father-in-law, there is no simple equation for directly computing the interest rate given the other three values (and it is the smart finance who listens to his future father-in-law—at least until after the wedding). Business calculators compute this value by any number of approximation methods. I chose to use a simple binary chop, as it is both easy to write and to understand.

Now that we have methods for computing each of the four values, given the other three, let's build a program to use them.

On the typical business calculator, the four keys, PMT, PV, i, and n each serve two purposes. First, you enter a value by keying in a number and then pressing the appropriate key. To compute one of the values once the others have been entered, you press "shift" ("2nd," "f," or whatever) and then the key of the value you want to compute. The program following this article works in much the same way, except that you enter a value by first pressing the key for the value you want to enter, and then typing in the value, followed by ENTER.

As an example of how to use this program, let's determine the monthly payment for a 30 year, 12.5% mortgage on

$52,500. After running the program (in FAST mode), you will see the current values of the payment, present value, interest rate, and number of payments. Enter the present value (the amount of the mortgage) by pressing V. The cursor will appear at the bottom of the screen, waiting for you to type in a value. Type in "52500" and press ENTER. 52500 now appears on the screen as the present value.

The interest rate of 12.5% is an annual interest rate, but mortgage payments are made monthly, so enter the interest rate by pressing I and then typing in ".125/12" and pressing ENTER. The monthly interest rate appears on the left of the screen, with the yearly rate to the right of it.

30 years of monthly payments is 360 payments, so press N, type in "360", and press ENTER.

Now that you have entered the other three values, you may compute the size of the payment. Press SHIFT-P (actually you are pressing ") and after a few seconds of thinking, you will see that the monthly payment, given these other factors, is $560.31.

Now, let's say that you want to see what would happen if you borrowed $55,000 instead. Simply enter a new value for V and press SHIFT-P again. You can do this to compute any one of the four values (calculating I takes a little longer though).

The program itself is fairly straightforward. Lines 10-40 simply initialize the four values to zeros (a good idea in general). Lines 50-90 display the four values on the screen. Lines 100 and 110 wait for a key to be pressed (the use of the PAUSE statement like this is documented in chapter 19 of the original Sinclair manual and in chapter 16 in the Timex/Sinclair manual). Line 120 is simply a small space optimization since the expression

"1-(1/(1+I)**N)"

is used in calculating both P and V. Lines 130-160 simply read in one of the four values, depending on which key was pressed, and lines 170-200 compute one of the four values, depending on which key was pressed.

The only lines that really need some explanation are 220-290, which compute the interest rate using a binary chop algorithm. A binary chop is a method of computing a value by making successive approximations, adjusting the approximation as needed, until the correct answer is determined. It is called a binary chop because at the outset it is known that the correct answer lies within a certain range, and with each approximation, this range is chopped in half, until only the correct answer is left.

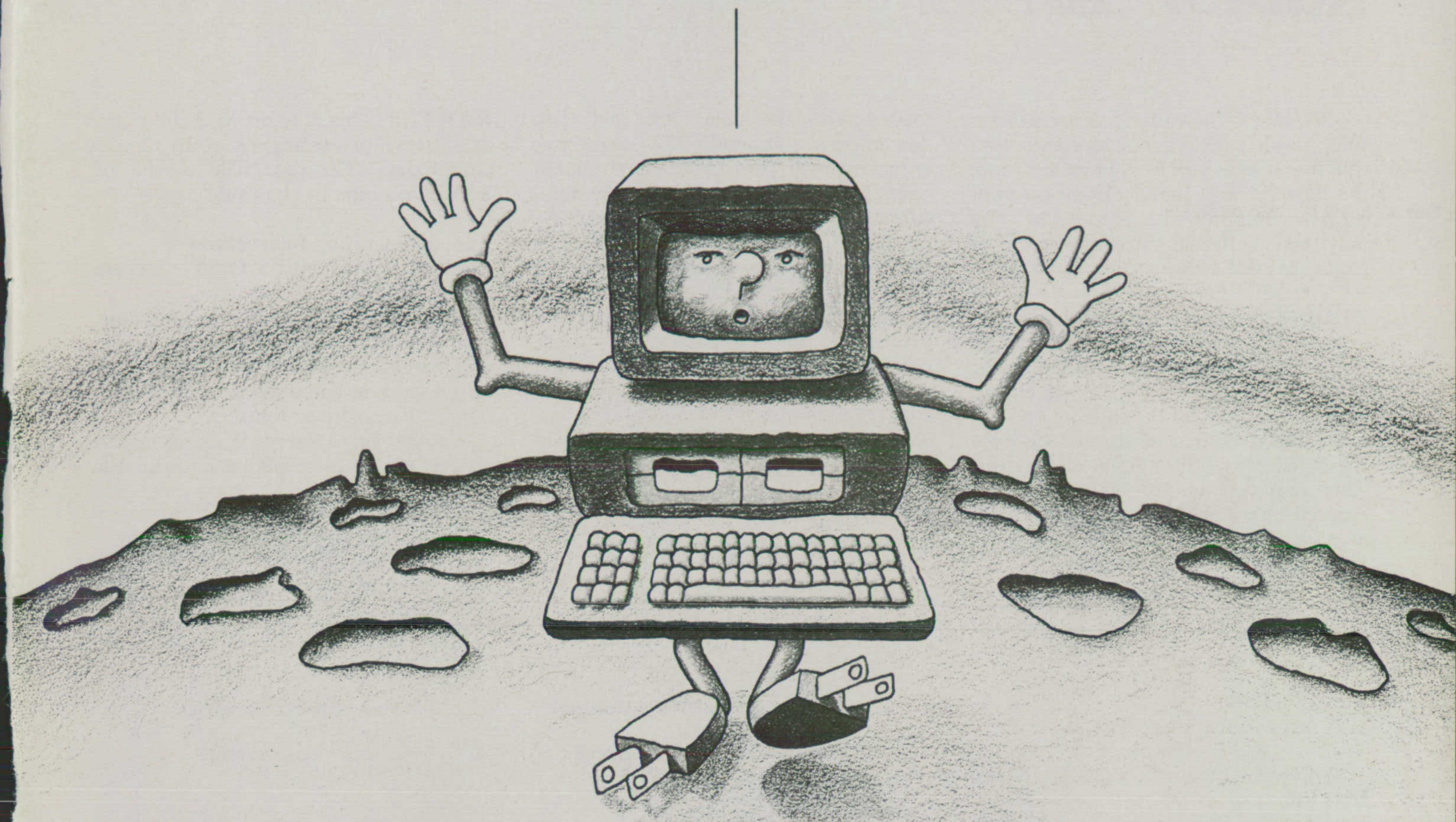
In our example, it is clear that the lowest possible value for the interest rate is 0 (line 220). It is also almost as clear that the highest possible value is P/V (line 230). If the interest rate were equal to P/V that would mean that the entire payment would be interest, with no payment to principal, and therefore the mortgage would never be paid off (actually, there are some variable rate mortgages available now where the monthly payment does not even cover the interest, but this program only works on mortgages that can eventually be paid off).

Listing 1.

```
  10 LET P=0
  20 LET V=0
  30 LET I=0
  40 LET N=0
  50 CLS
  60 PRINT "P=";P
  70 PRINT "V=";V
  80 PRINT "I=";I,"I*12=";I*12
  90 PRINT "N=";N
 100 PAUSE 40000
 110 LET K$=INKEY$
 120 LET D=1-(1/(1+I)**N)
 130 IF K$="P" THEN INPUT P
 140 IF K$="V" THEN INPUT V
 150 IF K$="I" THEN INPUT I
 160 IF K$="N" THEN INPUT N
 170 IF K$=CHR$ 11 THEN LET P=V*
I/D
 180 IF K$="/" THEN LET V=P/I*D
 190 IF K$="(" THEN GOSUB 220
 200 IF K$="<" THEN LET N=LN (P/
(P-V*I))/LN (1+I)
 210 GOTO 50
 220 LET LI=0
 230 LET HI=P/V
 240 LET I=(LI+HI)/2
 250 LET Z=V*I/(1-(1/(1+I)**N))
 260 IF Z=P THEN RETURN
 270 IF Z<P THEN LET LI=I
 280 IF Z>P THEN LET HI=I
 290 GOTO 240
```

Now that we have the initial range, we compute the midpoint (line 240) and compute the monthly payment using this midpoint as the guess of the interest rate (line 250). Note that we can not use our value of D from line 120 in this case since I is changing. If the payment computed here equals the payment we entered earlier (to the accuracy of the machine), then we have arrived at the correct value of I and can return (line 260). If not, then we determine whether the correct answer lies in the upper or lower half of the range we just used, adjust the range accordingly (lines 270-280) and try again. If the payment we computed is less than the actual payment entered (line 170), then our guess for I was too low and the correct answer lies in the upper half of the range. Therefore, the lower bound (LI) is adjusted upward. If the payment computed is more than the actual payment (line 280) then the corect answer lies in the lower half of the range and the upper bound (HI) is adjusted. Eventually this range becomes small enough to return just a single value. which is our answer.

"What more can I do?"



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CIRCLE 68 ON READER SERVICE CARD

AUDISY *Ron LeMon*

"AUDISY"—Audio Digitizer/Synthesizer—is a 65 byte machine code routine that allows you to digitize and store the data for any sound phrase on your ZX/TS computer with 16K RAM. You may then synthesize the sound at will or study the data field.

AUDISY Programming Instructions

Since our machine code contains an unlistable value (code 126), it cannot be stored in an ordinary REM statement. Instead we will load the code into an unlisted REM statement located between the listed program and the display file. This requires unique USR calls referenced below the display file (the variable F).

Enter the program as follows:

1) Type in a numbered REM statement containing 61 characters:

```
  1 REM XXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXX
```

Press ENTER.

2) Type in the immediate mode:

```
POKE 16509,118
```

3) Type in Listing 1. Press RUN and ENTER.

4) Type in the decimal machine code from Table 1, going from left to right and pressing ENTER after each number.

5) When all the code has been entered, delete the loader program by typing in the line number followed by ENTER. Do not use NEW or you will wipe out the code.

6) Type in Listing 2, the driver program. This requires 16K.

You are now ready to use the program.

AUDISY Operating Theory

AUDISY operates as two separate routines. A call to USR (F-66) starts the digitizer (see AUDISY disassembly). First, RAMTOP is automatically lowered to location 18000 to provide a 14000 byte storage area up to location 32000. This vast field will be used to store digitized waveform data and will provide an aperature just seconds wide depending on the mean frequency stored. The higher the mean frequency, the narrower the aperature.

As the digitizer operates, register D is loaded with the value 255 and then decremented to contain 254. Register A is loaded with zero to set up the input code. If no signal is present at the input (the ear jack), the value 63 is returned by register A which causes a jump to be made to decrement D and to recycle the input loop. If a signal is present at the input, the value currently in register D is placed into the present location in the data field pointed to by the HL register pair.

A predominance of value 254 indicates a high noise level or an input signal that has a high frequency component exceeding the sensitivity of the input loop. The lower the number stored in the data field the lower the frequency that it represents. The full scale sensitivity of the digitizer is calculated to be 295 Hz to 26KHz. These are theoretical limits and are drastically reduced by such factors as noise and stray input capacitance, etc.

The signal amplitude is important since any waveform not sufficiently loud will not be processed. Excessive signal, however, will cause distortion.

The synthesizer operates by addressing USR (F-36). One byte at a time, values are taken from the data field and loaded into register A which provides the timing delays for toggling the output. The output signal is provided at the mic jack on the computer and requires amplification. The Sinclair output bus is shared by the RF modulator. This means that the sound will be available over the TV audio system.

Only about $2\frac{1}{2}$K of memory is left after setting RAMTOP to provide the data storage area. This limits the user's program development. It is now possible, however, to LOAD a new program while not affecting the data stored above RAMTOP. This may prove useful when extensively processing or studying the stored data. The data field cannot be SAVEd on tape by the usual means.

Listing 1. 16K MC routine; 2K MC loader.

```
  10 DIM A$(65,4)
  20 LET F=PEEK 16396+256*PEEK 1
6397
  30 FOR I=1 TO 65
  40 INPUT A$(I)
  50 PRINT A$(I);
  60 POKE F+(I-67),VAL A$(I)
  70 NEXT I
```

Listing 2. 16K MC routine; 16K MC driver.

```
 100 FAST
 105 LET F=PEEK 16396+256*PEEK 1
6397
 110 RAND USR (F-66)
 115 PAUSE 4E4
 120 RAND USR (F-36)
 125 PAUSE 4E4
 130 GOTO 120
```

Audisy Operating Instructions

After LOADing AUDISY, prepare the input source. If you choose to digitize music or voice from a cassette tape, you will have to experiment with the volume control. It will take some practice to learn to cue the tape to the beginning of the digitizer routine.

Another input source is direct microphone. Plug a microphone into the mic input of your recorder or use the built-in condenser mic, if provided. Put in a blank tape and set the cassette to record. Press pause on the recorder if you do not want the tape to advance. Make sure the ear jack on the computer is connected to the ear jack on the tape recorder.

Table 1. Machine code data.

33	4	64	54	80	35	54	70
33	80	70	22	255	21	62	0
219	254	254	63	40	247	114	124
35	254	125	32	238	201	33	80
70	22	1	126	254	254	40	15
60	254	254	32	251	211	255	126
60	254	254	32	251	219	254	21
32	233	124	35	254	125	32	225
201							

Table 2. AUDISY disassembly.

```
The value of F
-66 LD HL,16388    ;set RAMTOP
-63 LD (HL),80      to 18000
-61 INC HL
-60 LD (HL),70
-58 LD HL,18000    ;data field start.
-55 LD D,255
-53 DEC D          ;this loop
-52 LD A,0          counts down
-50 IN A,254        until INPUT
-48 CP,63           acknowledged.
-46 JR Z,-53
-44 LD (HL),D      ;store data byte.
-43 LD A,H         ;test for end of
-42 INC HL          data field; if not
-41 CP,125          end then find next
-39 JR NZ,-55       loc. and recycle.
-37 RET
-36 LD HL,18000    ;data field start.
-33 LD D,1         ;set no. of cycles -1.
-31 LD A,(HL)      ;set delay (freq).
-30 CP,254         ;disregard
-28 JR Z,-11       ;noise.
-26 INC A
-25 CP,254         ;test for end
-23 JR NZ,-26       of delay.
-21 OUT 255,A      ;turn on output.
-19 LD A,(HL)      ;set delay (freq).
-18 INC A
-17 CP,254         ;test for end
-15 JR NZ,-18       of delay
-13 IN A,254        turn off output.
-11 DEC D          ;next cycle.
-10 JR NZ,-31
 -8 LD A,H         ;test for end of
 -7 INC HL          data field; if not
 -6 CP,125          end then next data
 -4 JR NZ,-33       byte and recycle.
 -2 RET
```

Ron LeMon, 1601 West 400 South, #86, Salt Lake City, UT 84014. AUDISY and DEFMAG are available on one tape from the author for $14.95 pp.

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CIRCLE 57 ON READER SERVICE CARD

To digitize a sound source, enter RUN while the source is playing. If the input sound is of sustained intensity, it will allow the machine code routine to cycle out and return to Basic. After running the AUDISY driver with an input signal present, the user is signalled that digitizing is complete by the brief flash on the screen as the computer goes into infinite PAUSE (line 115).

Then press any key (except BREAK) to operate the synthesizer. The synthesizer can operate repeatedly by pressing a key to interrupt PAUSE. Press BREAK and then enter RUN to digitize a new sound phrase. You may also delete line 125 for a continuously repeating playback. Remember that any time changes are made to the program listing the display file moves about. This means that the program line establishing the variable F must be entered directly or read during the program operation in order to properly reference the USR addresses.

You may hear the synthesizer output directly over the TV set. Turn up the volume and adjust the fine tuning control for the best sound. For better fidelity you may record the output on tape to be played back. Connect the mic jack of the computer to the mic jack of the recorder.

I prefer to use a small amplifier to reproduce the synthesized sound. The Archer Mini Amplifier with built-in speaker (cat. #277-1008) from Radio Shack is ideal for this project.

Figure 1. Program A.

```
1000 FOR I=18E3 TO 32E3 STEP 64
1010 FAST
1015 CLS
1020 FOR J=0 TO 63
1030 PLOT J,INT ((PEEK (I+J))/6)
1040 NEXT J
1050 SLOW
1060 FOR K=1 TO 100
1070 NEXT K
1080 NEXT I
```

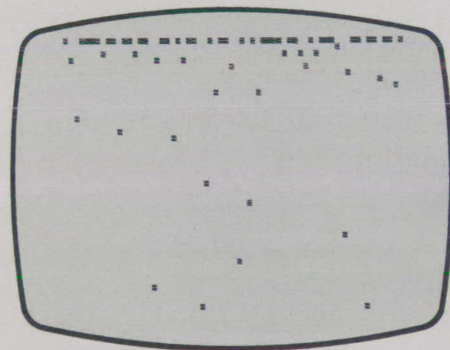
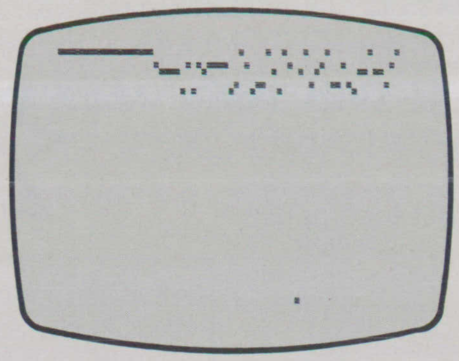


Figure 2. Program B.

```
1000 FOR I=18E3 TO 32E3 STEP 64
1010 FOR J=0 TO 63
1020 PLOT J,INT ((PEEK (I+J))/6)
1030 NEXT J
1040 NEXT I
```

Figure 3. Program C.

```
1000 DIM N(10)
1010 FOR I=0 TO 63
1020 FOR J=1 TO 10
1030 LET N(J)=PEEK (((I*218)+18E
3)+(2*J))
1040 NEXT J
1050 LET A=INT ((N(1)+N(2)+N(3)+
N(4)+N(5)+N(6)+N(7)+N(8)+N(9)+N(
10))/10)
1060 PLOT I,INT ((A*1.6)-363)
1070 NEXT I
```



```
CHANGE VERTICAL RANGE FOR
PROGRAM C WITH ANY OF THESE
LINES:

1060 PLOT I,INT (A/6)

1060 PLOT I,INT ((A/2.55)-56)

1060 PLOT I,A-211

1060 PLOT I,INT ((A*2)-465)
```

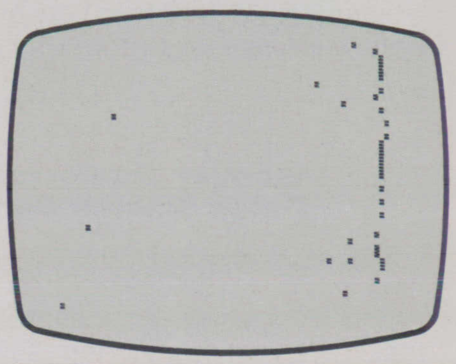
Figure 4. Program D.

```
1000 LET C=0
1010 FOR I=18E3 TO 32E3 STEP 218
1020 LET A=0
1030 LET B=254
1040 FOR J=1 TO 218
1050 LET D=PEEK (I+J)
1060 IF D>=234 THEN GOTO 1080
1070 IF A<=D THEN LET A=D
1080 IF B>=D THEN LET B=D
1090 NEXT J
1100 FOR K=INT (B/6) TO INT (A/6
)
1110 PLOT C,K
1120 NEXT K
1130 LET C=C+1
1140 IF C=64 THEN STOP
1150 NEXT I
```

```
CHANGE LOW PASS FILTRATION FOR
PROGRAM D WITH THE APPROPRIATE
LINE CHANGE:

FOR NO FILTRATION:

1060 IF D>=255 THEN GOTO 1080

FOR LOW PASS FILTRATION:

1060 IF D>=254 THEN GOTO 1080

FOR EXTREMELY LOW PASS
FILTRATION:

1060 IF D>=127 THEN GOTO 1080
```

Figure 5. Program E.

```
1000 FOR I=18E3 TO 32E3 STEP 2
1005 IF PEEK I=254 THEN GOTO 101
5
1010 PLOT INT ((PEEK I)/4),0
1015 IF PEEK (I+1)=254 THEN GOTO
 1040
1020 PLOT INT ((PEEK (I+1))/4),1
1030 SCROLL
1040 NEXT I
```



Experimenter Notes

This section deals with ways of conveniently displaying the huge data field stored above RAMTOP. The simplest routines display the data field as 218 frames of 64 byes each plotted onto the screen. Program A plots a frame at a time with a pause between. Program B superimposes frame upon frame as a possible method for observing repeating patterns. The higher frequencies are at the top, and time advances from left to right. Similarly, Program C averages samples from the data field and plots them onto one screen frame. Examples are shown to adjust ranging. Program D simulates the modulation envelope of the sound sample. Maximum and minimum values are plotted and can be altered to show the effects of filtration. Program E scrolls plotted data from the bottom of the screen. This program compresses the time scale by eliminating all bytes that contain noise (code 254) allowing easier visualization of the component waveforms. Higher frequencies are to the right, and time advances from top to bottom. It may take a while for significant displays to develop with any of these programs.

Whether you use AUDISY to characterize waveforms for voiceprint identification in a science fair project or as an amusing mimic toy, you will find this a stimulating project.

in and out of sync

David H. Ahl
David Grosjean

What's a Brand X doing in *SYNC* Magazine?

With improving technology and intensifying competition in the small computer market, more and more computers are available at prices within a few steps of the Timex/Sinclair units. Our sister publication, *Creative Computing,* evaluates many of these systems. We would like to share these reviews with those of you considering another computer.

In addition, we will sometimes take a program or two and show what it would be like to write and run the program on the Brand X computer compared to the Timex/Sinclair. You will probably find these tutorials a useful aid for converting programs from other sources to your Timex/Sinclair computer.

The Video Technology VZ200

David H. Ahl

The Video Technology VZ200 is a compact microcomputer with a great deal of capability and many unexpected features at a very attractive price.

The VZ200 is based on the 6502 microprocessor (used in the Apple, Commodore, and Atari computers). It comes with a 12K ROM and a sparse 4K RAM. The ROM includes the monitor and an excellent implementation of Microsoft Basic. The RAM can be expanded with either a 16K or 64K module.

The computer is 11.4" x 6.3" x 2". Two-thirds of the top is taken up by the keyboard. The 45 keys are "Chiclet" style rubber with a very short throw. Touch typing is possible only in a rather limited way. Although the key spacing is the same as on a regular typewriter, the feel is different. Much more disasterous for touch typing is the use of a single shift key and a space key instead of a space bar. Several keys do not have the expected characters; e.g., the question mark is on the L key.

On the brighter side, each key provides several functions in addition to typing a character. All the Basic commands, keywords, and functions can be produced by holding the control key (or control and RETURN) while the key is pressed. Each key produces two Basic keywords and one or two regular characters. This is most welcome since on the computers which use a single keystroke the number of Basic keywords is limited to the number of keys.

The VZ200 with 16K RAM memory pack

When a key is pressed, a short "beep" indicates one keystroke. If the key is held down, it automatically repeats with a beep indicating each key entry.

The computer has an on/off light on top and an on/off switch on the side.

The Basic Language

The Basic includes 9 commands, 27 statements, 11 arithmetic functions, 9 string functions, 7 graphics and sound functions, and the expected arithmetic, relational, and Boolean operators.

Among the statements that we do not always see in a computer in this price range are: INP (reads the contents of input ports); OUT (sends values to output ports); USR (calls an assembly language subroutine); and COPY (copies the content of the screen to a printer).

We were also pleased to find both PRINT USING and PRINT @ implemented. The latter is useful for printing at different screen locations without having to use blank print lines or tabs. However, a tab function is also available.

On-Screen Editing

Full on-screen editing makes it a pleasure to program on the VZ200. The line to be

For editing, the directional keys put the cursor wherever you want it on the screen.

edited is listed, by itself, with the whole program or with a group of lines. The cursor is moved by the directional keys to the character to be changed. Type the change, move the cursor to the end of the line, and type RETURN. Voila! The change is made. On-screen editing can also use DELETE, INSERT, and RUBOUT.

We had two small problems with on-screen editing. First, it was all too easy to hit the shift key instead of the control key because the cursor directional keys are activated by pressing the control key on the left and a directional key on the right. Probably the user can adapt to this after some practice. Second, after a while the editing buffer seemed to overflow and further editing was not accepted. Admittedly, we were trying to push the computer over the brink, so it is unlikely that this will be a problem in normal use.

Video Display

The VZ200 produces a composite video signal for a monitor and an RF signal on Channel 2 or 3. We found the monitor signal rock steady, whereas the RF signal required very precise fine tuning.

Output is in one of two modes: low-resolution text and graphics or medium-resolution graphics only. In the mixed mode, the display has 16 lines of 32 characters each. Alphabetic characters are available in uppercase only. Graphics are made from 16 characters which divide each screen location into four boxes with all combinations as on the ZX/TS computers.

Each of these characters can be turned on in any of eight colors. The off portion shows as black which can be considered a ninth color. Alphanumerics are displayed either as yellow on green or yellow on buff. Individual characters or the entire screen can be changed to inverse. Only one background color, green or buff, can be used at a time, and it does not affect the color of the graphics characters.

Low-resolution graphics characters can be typed into programs directly from the keyboard or called with CHR$(128) to CHR$(255) from a program.

In medium-resolution graphics mode, the screen is 128 x 64 pixels. Each pixel is turned on by the command SET (x,y) and turned off by RESET (x,y); POINT (x,y) examines whether a pixel is on or off. The first two commands are equivalent to PSET and PRESET in some other computers.

In this graphics mode, only three colors plus the background color are available simultaneously.

Any RAM location, including screen locations, can also be changed and examined by POKE and PEEK.

Musical Sounds

The single sound channel can produce 31 frequencies (2 1/2 octaves) and nine note durations (from a dotted half note to a thirty-second note). The command takes the structure: SOUND (p,d) where p is the pitch (1 to 31; 0 for a rest) and d is the duration.

Problems

In pushing the computer to the brink, we found several situations in which the only way of recovery was to turn the computer off. Even BREAK (the equivalent of RESET on some other machines) failed to return control to the user.

The most common irrevocable condition was LLIST which normally lists a program

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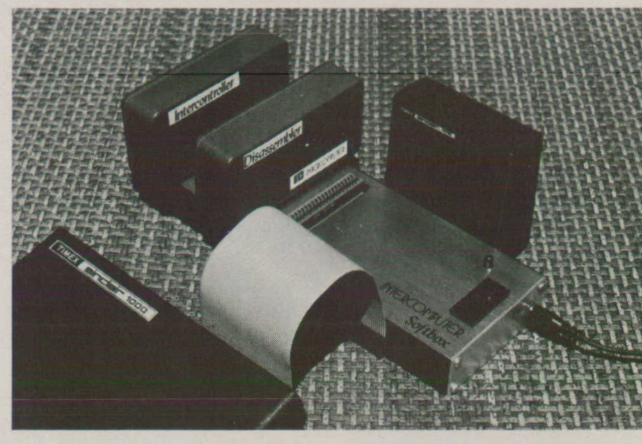

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on the line printer. However, if no printer is attached, the computer hangs. This is particularly bad because the rubberized keys tend to bounce a bit, and it is easy to type LLIST instead of just plain LIST. If you have a long program in the computer and have to turn it off because it hangs up, as we did four or five times, you are forgiven if you become a bit surly toward the machine. The surest cure is to use Control/4 to list a program. After a while we learned to do this.

Other things that would hang the machine are in the same family, i.e., trying to use a peripheral device that is not attached. In some cases the VZ200 gave an error message, but in others it went into never-never land.

We also had a problem loading the programs from the demo tape. We tried three recorders, including a high quality digital unit, but all the VZ200 would say was "FOUND T: Program Name." Since we saw the programs load at CES, we assume we got a faulty demo tape.

Peripherals

The interface to a standard cassette recorder operates at a Baud rate of 600 bps. Although this is somewhat slower than other new computers which have rates up to 2400 bps, nevertheless it is twice as fast as machines of just a few years ago. A program that fills the entire 4K of memory loads in about 54 seconds; a 16K program loads in about four minutes. Bear in mind, however, that most 16K programs do not use 16K of code because much of the RAM is taken by dimensioned arrays and the like.

The manufacturer specifications note that a peripheral expansion bus is built-in; however, we are not quite sure what this means. It appears that expansion modules, presumably, to be connected to printers, modems, or other external devices, can be plugged into the back of the computer.

The V-Tech printer is a Seikosha unit which we have previously found to be satisfactory and cost effective. It requires an interface module which plugs into the interface bus. Since the Seikosha printer uses a standard Centronics parallel signal, presumably other printers with similar signal requirements could be used, although they will probably not reproduce the screen graphics correctly.

Documentation

Included with the VZ200 are a 149-page Basic Reference Manual, a 24-page booklet of 21 Basic Application Programs, and an eight-page User Manual describing how to set up the system.

While some of the documentation obviously shows its Chinese (Hong Kong) heritage, the majority is well written, if not awfully well edited. The Basic manual provides a good introduction to the rudiments of the language although some of the sample programs leave something to be desired (the one to illustrate arrays is particularly bad). POKE and PEEK are explained in only the most cursory way, and we have no idea what the "New Characters Code" chart on p. 104 is for. Also, sadly lacking is an index which is very useful in a reference manual.

On the other hand, the manual is as good as most and better than many. It is just a shame that documentation is the weak spot of so many otherwise excellent computers.

Summary

All in all, the Video Technology folks in Hong Kong have done an excellent job producing a versatile small computer. We were impressed with the excellent implementation of Microsoft Basic, full on-screen editing, repeat keys, and easy-to-use graphics features. The idiosyncrasies were a bit annoying, but owners will get used to them and probably not notice them after a week or two of use. Bottom line: the VZ200 is a great value for the suggested price of under $100.

Video Technology (U.S.), Inc., 2633 Greenleaf, Elk Grove Village, IL 60007.

Plotting a Projectile

David Grosjean

In this issue we will compare programming the VZ200, the color and sound computer by Video Techonology, and the TS1000. The project we will undertake is the plotting of a projectile.

Starting with a Clear Screen

Let's start with a simple clear screen and plot statement.

TS1000:

```
 10 CLS
200 PLOT X,Y
```

VZ200:

```
5 CLS
40 MODE(1):COLOR 4
200 SET(X,Y)
```

If you look at the VZ200 program, you will notice that the computer has to be put into a special graphics mode with line 40. This means that you cannot have the medium resolution graphics and text on the screen at the same time. This will become a problem when we try to turn this into a game.

The Projectile Equations

The equations for the horizontal and vertical position of a projectile are:

X=V*COS(A)*T

Y=V*SIN(A)*T-1/2*G*(T*T)

V is the velocity; T is the time; G is the effect of gravity. These equations can be worked into the program like this:

TS1000:

```
 20 LET V=1000
 30 LET D=57.3
 40 LET A=45
 50 LET C=V*SIN (A/D)
 60 LET C1=V*COS (A/D)
 80 FOR T=0 TO 44 STEP .5
 90 LET X=C1*T
100 LET Y=C*T-16*T*T
180 LET X=X/500
190 LET Y=Y/500
220 NEXT T
```

VZ200:

```
10 A=45
20 V=1000:G=32
30 D=57.3
50 C=V*SIN(A/D)
60 C1=Y*COS(A/D)
80 FOR T=0 TO 45 STEP .5
90 X=C1*T
100 Y=C*T-16*T*T
180 X=X/250
190 Y=Y/250
220 NEXT T
```

As you will notice, the range on the VZ200 increased due to the higher resolution of the graphics, but we did not change the velocity of the projectile. Instead, we changed the number which we divide X and Y by to fit the projectile on the different screen size.

In these programs, D is a factor that converts degrees to radians which are what the computer wants. C and C1 are constants for each firing angle. When you RUN this program on the VZ200, you will notice that the plot is upside down. This is because the vertical distances are measured from top to bottom instead of bottom to top as on the TS1000. Change line 190 in the VZ200 program to

```
190 Y=61-Y/250
```

Setting the Gun Angle

Now we can modify the programs to accept a gun angle from 1 to 90 degrees.

TS1000:

```
 40 PRINT "ANGLE OF GUN?"
 45 INPUT A
 70 LET T1=2*C/32
 80 FOR T=0 TO T1 STEP .5
230 GOTO 50
```

VZ200:

```
10 INPUT "ANGLE OF GUN";A
70 T1=2*C/G
80 FOR T=0 TO T1 STEP .5
230 GOTO 50
```

Making a Game

Now that we have a working, however simple, projectile program, let's try to make a game out of it. The following games are our projectile programs tightened up a bit and with the provisions for a target.

Setting up the Target

On the VZ200 the range is 127,000 yards, and on the TS1000 32,000 yards (1000 yards for every horizontal position on the screen). This will throw the equation off a little since the gun cannot shoot the

projectile 127,000 yards. (If this bothers you, think of the yards on the VZ200 as 11-inch feet.)

Although there are 64 pixel positions on the TS1000, the target is a T which takes up two pixels. You can hit the left or the right of the T so the number of effective horizontal positions is reduced to half. Notice that, since the VZ200 cannot have text and graphics on the screen at once, line 100 forms a special target, while on the TS1000, a simple PRINT AT command in line 60 does the same thing.

TS1000:

```
 20 LET V=1000
 40 LET K=INT (20000*RND)+12000
 50 CLS
 52 PRINT "RANGE = 32000 YDS"
 60 PRINT AT 21,INT (K/1000);"T"
 70 PRINT AT 1,0;"ANGLE OF GUN?"
 80 INPUT A
 90 IF A<1 OR A>90 THEN GOTO 90
120 LET C=V*SIN (A/57.3)
130 LET C1=V*COS (A/57.3)
140 LET T1=2*C/32
150 FOR T=0 TO T1 STEP .5
160 LET X=C1*T/500
170 LET Y=T*(C-16*T)/500
180 PLOT X,Y
190 NEXT T
```

VZ200:

```
20 V=1000
40 K=INT(97000*RND(0))+30000
50 PRINT "RANGE = 127000 YDS"
60 PRINT "TARGET AT";K;"YDS"
70 INPUT "ANGLE OF GUN";A
80 IF A<1 OR A>89 THEN 70
90 MODE(1):COLOR4
100 FORL=1 TO 4:FORL1=1 TO 4:SET
(INT(K/1000-4)+L1,59+L):NEXT:NEXT
130 C=V*SIN(A/57.3)
140 C1=V*COS(A/57.3)
150 T1=2*C/32
160 FOR T=0 TO T1 STEP .5
170 X=C1+T/250
180 Y=61-(T*(C-16*T)/250)
190 SET(X,Y)
210 GOTO 210
```

Detecting a Hit

We now have a target, but it is of no use unless the computer can detect its destruction. The following lines detect a hit. Notice how the techniques of detecting a hit target differ. The VZ200 must compare each position of the target, which is four positions wide, with the last position of the projectile; the TS1000 does the same thing but uses the PRINT AT position used by the target to compare to the last position of the projectile. This is, of course, simpler. Line 300 in the VZ200 version is a special "explosion" accompanied with some sounds. You can experiment at this point to find a better explosion.

TS1000:

```
200 IF INT (X/2)=INT (K/1000) THEN GOTO 300
250 GOTO 50
300 PRINT AT 21,INT (K/1000)-2;"[illegible]"
310 PAUSE 250
340 GOTO 30
```

VZ200:

```
220 FOR L=1 TO 4:IF INT(K/1000)-
L=INT(X) THEN 300
225 NEXT L
250 GOTO 50
300 FORL=1 TO 30:SET(40+87*RND(0
),40+22*RND(0)):SOUND31,1:NEXT L
310 PRINT "HIT! HIT! HIT!"
340 GOTO 30
```

Making the Next Shot

Now we can add the response the computer will make to a missed target. The following lines tell how far away your shot was from the target and lets you try again. Line 210 in the VZ200 version is a delay loop so you have time to see the last position of the projectile.

TS1000:

```
210 LET E=INT (K-(32000*SIN (.035*A)))
220 IF E<100 THEN PRINT AT 0,0;"OVER BY ";ABS E;" YDS"
230 IF E>100 THEN PRINT AT 0,0;"UNDER BY ";ABS E;" YDS"
240 PAUSE 250
```

VZ200:

```
210 FOR L=1 TO 3000:NEXT L
230 IF INT(K/1000)>X THEN PRINT
"UNDER BY";K-X*1000;"YDS"
240 IF INT(K/1000)<X THEN PRINT
"OVER BY";X*1000-K;"YDS"
```

Providing Your Shots

The computer can now detect hits and misses. This is where the game part comes in. The following lines provide you with 5 individual targets with a maximum of 5 attempts to hit each target. If you fail to hit a target in 5 shots, you lose. S is the number of shots you have taken per target; S1 is your total number of shots; and Z is the total number of targets.

TS1000:

```
  5 LET Z=0
 10 LET S1=0
 30 LET S=0
 55 IF S=5 THEN GOTO 260
100 LET S1=S1+1
110 LET S=S+1
260 PRINT AT 0,0;"ENEMY GOT YOU FIRST"
270 GOTO 370
320 LET Z=Z+1
330 IF Z=5 THEN GOTO 350
```

VZ200:

```
10 S1=0:Z=0
30 S=0
55 IF S=5 THEN 260
110 S=S+1
120 S1=S1+1
260 PRINT "THE ENEMY GOT YOU FIR
ST!"
270 GOTO 370
320 Z=Z+1
330 IF Z=5 THEN 350
```

Evaluation and Restart

Finally, we need an evaluation and a mechanism to restart the game. The following lines do this.

TS1000:

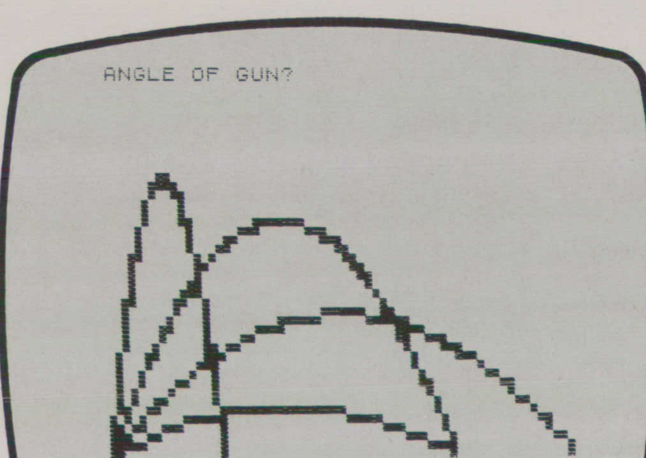
```
350 PRINT AT 0,0;S1;" ROUNDS USED "
355 IF S1<10 THEN PRINT "GREAT JOB"
360 IF S1>15 THEN PRINT "YOU CAN DO BETTER"
370 PRINT "PLAY AGAIN?  "
380 INPUT Z$
390 IF Z$="Y" THEN RUN
```

VZ200:

```
350 PRINT S1;"ROUNDS USED"
355 IF S1<10 THEN PRINT "GREAT J
OB!"
360 IF S1>15 THEN PRINT "YOU COU
LD HAVE DONE BETTER"
370 INPUT "PLAY AGAIN";Z$
380 IF Z$="Y" THEN RUN
```

Improving on the Game

Of course, these artillery-type games are very simple. They provide a basic game which you can elaborate on or experiment with to develop different possibilities. You might want to improve on the graphics or sound on the VZ200 or perhaps make a really BIG explosion. Although the TS1000 has no color or sound, the program can still be greatly improved. You could add hi-res graphics through either a hardware add-on or a software program. You might want to add a sound unit which will give the sound effects or add a routine to provide some sound (e.g., AUDISY).



New Product Reports ...

Integrated Software For The TS2068

A new series of integrated TS2068 software has been announced by E. Arthur Brown Company. Programs in the series have the ability to read and write data from tape and are pre-configured for upgrade to the TS Microdrive as soon as it's available. Because they're integrated, these programs can read data tapes from other programs within the series. This means you only have to enter data once to have it evaluated by several different programs. For example, you can create a spreadsheet and then feed that spreadsheet data to the plotting program for graphic illustration.

This series has been available for a few months now in a 16-64K TS1000/TS1500 version known as Mega Software. The new TS2068 series is suitably called: ***Mega 2068 Software.***

There are two integration groups in the Mega 2068 Series. The "2068 Master" group consists of a desk top organizer like the Apple® Lisa®, a spreadsheet, a word processor, a data base, a statistical analyzer, and a graph plotter. The "2068 Wealth" group is a small business set up. It consists of an invoicing program, accounts receivable, accounts payable, inventory management, and a net earnings program that produces profit/loss statements and balance sheets.

Mega 2068 Software sells for \$20-\$25 per program and is available from E. Arthur Brown Company, 1702-S2N Oak Knoll Drive, Alexandria, MN 56308. For more information, call or write and ask for a free catalog.

MKIV Keyboard Kit At Low $34.95 Price

The MKIV Keyboard in assembled form was introduced last Spring by E. Arthur Brown Company. It features top quality keyswitches, a space bar, and sublimated legends on the keytops for sharpness and long life. The company says there *is* no finer keyboard available and that's why it costs \$89.95. But now, if you don't mind putting it together yourself, you can get the MKIV in kit form for \$34.95. The kit comes complete with instructions and all parts, except the molded case, to construct a MKIV keyboard. The molded case is \$14.95 extra. Please add \$4.95 for shipping and handling. The MKIV keyboard is compatible with TS1000 and TS1500 computers. Order from E. Arthur Brown Company, 1702-S2N Oak Knoll Drive, Alexandria, MN 56308.

The MKIV Keyboard

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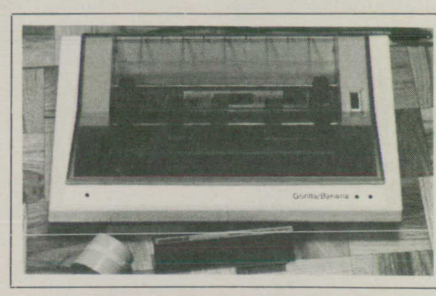
E. Arthur Brown Company announces a special package price on full size 80 column printers. For \$294.95 you get the popular Gorilla Banana dot matrix printer, a Memotech Centronics Parallel interface for upper and lower case letters, and a cable to connect everything to your TS1000/TS1500 computer. This system is fully compatible with Memo-Text and Memocalc Wordprocessing and Spreadsheet software and is available for immediate delivery. Send \$294.95 plus \$6.95 for shipping and handling to E. Arthur Brown Company, 1702-S2N Oak Knoll Drive, Alexandria, MN 56308.



Gorilla Printer Package

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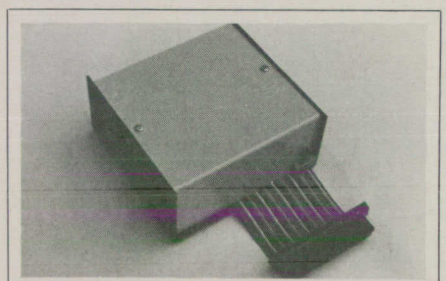

MMRY-REZ 64K RAM

Just released this Fall is the MMRY-REZ 64K RAM from E. Arthur Brown Company. The new RAM pack is a design enhancement of the former ZX-G unit, so popular a year ago. Basically, it provides a standard 64 K of RAM along with circuitry for high resolution graphics up to 192 x 256 pixels. What's more, it comes with high resolution graphics software to boot. Unlike other High Resolution systems, you don't have to program MMRY-REZ to use it. Tell it to draw a circle and it does so instantly. It draws anything instantly. It supports computer animation, too.

The 64K of RAM is built for compatibility with your system. The 8-16K region is fully switchable, so MMRY-REZ can operate with printers, modems, disks, or EPROM software. Quite a system, it's true. And, for a limited time you can get it at a special introductory price. Comparable systems *without software* cost \$250. MMRY-REZ 64's regular price is \$189.95. But the special price is \$149.95 plus \$5.95 for shipping and handling. Order from E. Arthur Brown Company, 1702-S2N Oak Knoll Drive, Alexandria, MN 56308. The MMRY-REZ 64K RAM is designed for use with the TS1000 and ZX81 computers. Call or write to find out about TS1500 compatibility.

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CIRCLE 3 ON READER SERVICE CARD

DEFMAG *Ron LeMon*

DEFMAG—Digitally Encoded FM Audio Generator—is a 29 byte machine code routine that allows you to store audio frequency data and to synthesize the facsimile sound at will. You may use complex mathmatical formulas to provide digitally sampled values from any continuous number field. These values are correlated to the audio spectrum so you can "hear" the resultant waveform. One version of the DEFMAG driver uses a single byte of the data storage area to hold the value from an individual key pressed. It turns the keyboard into a crude electronic organ.

The synthesized sound can be played through the TV audio system simply by turning up the TV volume control and adjusting the fine tuning for optimum sound. Better fidelity can usually be obtained from the mic output from the computer. Make the mic-to-mic connection between your ZX/TS computer and your recorder in the usual way. The sound generated by DEFMAG may be recorded onto tape, monitored by an earphone plugged into the cassette ear jack or amplified though some other high impedance input.

DEFMAG Programming Instructions

The frequency data storage area of this routine must be able to contain zero or any positive integer up to 255 that can be POKEd in. Since certain values such as 118, 126, and 127 cause problems in LISTing, DEFMAG cannot be stored in an ordinary REM statement. Instead we will load the DEFMAG machine code and set up the frequency data storage area in an unlisted REM statement located between the listed program and the display file. This requires unique USR calls referenced to the display file (the variable F).

Ron LeMon, 1601 West 400 South, #86, Salt Lake City, UT 84014. DEFMAG and AUDISY are available on one tape from the author for $14.95 pp.

The programming steps are as follows:

1) Create a REM sttement to hold 256 data bytes and 29 machine code bytes. Type in the REM filler program in Listing 1. To use the REM filler, in FAST mode, EDIT line 50 and key in a series of Xs as efficiently as you can. When you think you have depressed the X key a total of 280 times, press RUN and ENTER. The screen prompt will tell you how many Xs to add or delete to be correct. When the REM statement needs 0 characters, the command in line 30 will automatically isolate this area from the rest of the LISTed program, and the REM line will not be displayed on the screen. The screen should now look like Listing 2.

Listing 1. REM filler program.

```
  10 LET A=282
  20 LET B=PEEK 16642+256*PEEK 1
6643
  30 IF A-B=0 THEN POKE 16640,11
8
  40 PRINT "REM NEEDS ";A-B;" BY
TES"
  50 REM XXXX
```

Listing 2. REM line completed.

```
  10 LET A=282
  20 LET B=PEEK 16642+256*PEEK 1
6643
  30 IF A-B=0 THEN POKE 16640,11
8
  40 PRINT "REM NEEDS ";A-B;" BY
TES"
```

Listing 3.
MC loader program before loading MC.

```
  10 LET F=PEEK 16396+256*PEEK 1
6397
  20 DIM A$(29,4)
  30 FOR I=1 TO 29
  40 INPUT A$(I)
  50 PRINT A$(I);
  60 POKE F+(I-31),VAL A$(I)
  70 NEXT I
```

Figure 1. Machine code table.

```
255 33  0   0   126 254 255 200
6   0   211 255 94  28  29  32
253 219 254 28  123 190 32  251
16  240 35  24  231
```

2) Delete the remaining lines of the REM filler by entering each line number and ENTER. Be sure not to use NEW or you will wipe out the storage area.

3) Type in Listing 3, the machine code loader program.

4) Hit RUN and ENTER. In response to the L cursor enter the first number in the machine code table in Figure 1 and press ENTER. Continue entering the numbers (left to right) pressing ENTER after each. When all are entered, delete the lines of the loader program by typing each line number and hitting ENTER. Do not use NEW or you will erase the code. It is a good idea to SAVE the program at this point.

5) Type in the Driver program of your choice (A, B, C, D).

You are now ready to try the program.

DEFMAG Operating Theory

Since DEFMAG resides immediately below the display file, its address moves around as changes are made in the program listing. The only way to track DEFMAG USR addresses is by their relationship to the display file (-F). If any address is incorrect by just one byte the entire system can go haywire. The value of F must be updated as program changes are made.

A call to USR (F-29) loads the HL register pair with the address of the first byte of frequency data (F-285). The contents of that byte are tested to see if it contains the "stop code" 255. If the stop code at (F-30) or code 255 located anywhere else in the data field is encountered, the MC routine returns to Basic.

If the stop code is not encountered then register B is loaded with "duration" data that has been POKEd in. Register B is actually used to count down the number of cycles of the given frequency.

Next the output is turned on and a delay is begun that determines the period of the high logic half cycle as specified by the frequency data byte. When the delay is complete the output is turned off

Figure 2. DEFMAG disassembly.

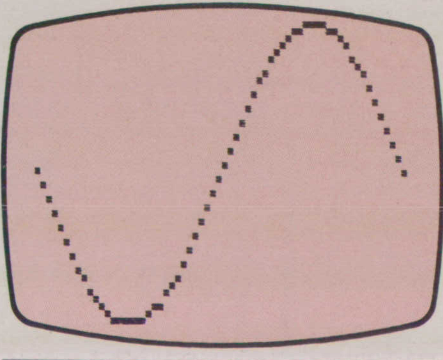
```
The value of F
-30 STOP CODE,255
-29 LD HL, address of first storage byte
-26 LD A,(HL)     ;test for
-25 CP,255         stop code.
-23 RET Z
-22 LD B, duration
-20 OUT 255,A     ;turn on output.
-18 LD E,(HL)
-17 INC E
-16 DEC E
-15 JR NZ,-16
-13 IN A,254       turn off output.
-11 INC E
-10 LD A,E
 -9 CP (HL)
 -8 JR NZ,-11
 -6 DJNZ,-20      ;jump to begin next cycle.
 -4 INC HL        ;move counter to next data byte.
 -3 JR -26        ;start over with new data byte.
```

Figure 3. Test formulas.

```
  60 POKE F-285+I,ABS INT (254-9
1.5*LN (I+1))

  60 POKE F-285+I,ABS INT (288-3
4*SQR (I+1))

  60 POKE F-285+I,INT (LN (I+1)*
46)

  60 POKE F-285+I,INT ABS ((I-12
7)*2)

  60 POKE F-285+I,INT ABS (255*S
IN (I/81.5))

  60 POKE F-285+I,127-INT (127*S
IN (I/80.31))

  60 POKE F-285+I,127-INT (127*C
OS (I/80.31))

  60 POKE F-285+I,ABS (61-INT (1
90*SIN (I/40.155)))

  60 POKE F-285+I,ABS (61-INT (1
90*COS (I/40.155)))

  60 POKE F-285+I,127-INT (127*S
IN ((I+1)*(I+1)))

  60 POKE F-285+I,127-INT (127*C
OS ((I+1)*(I+1)))

  60 POKE F-285+I,127-INT (127*S
IN (2*I+2))

  60 POKE F-285+I,127-INT (127*C
OS (2*I+2))

  60 POKE F-285+I,127-INT (127*S
IN (I+1))

  60 POKE F-285+I,127-INT (127*C
OS (I+1))
```

Figure 4.
Tester Program and plotted waveform.

```
  10 FAST
  20 FOR I=0 TO 254 STEP 4
  30 LET A=127-INT (127*SIN (I/4
0.155))
  40 PLOT I/4,INT (A/6)
  50 NEXT I
```



for a delay time also determined by the data byte. This series of on-off pulses recycles until register B counts down to zero. Then HL is incremented to the next data byte and the process repeats.

There is an anomaly in this type of synthesis. Since each tone that is generated has the same number of cycles, higher frequencies will have a tone of shorter duration since the period is shorter at those frequencies. Some important addresses to know are:

First frequency data byte:	(F-285)
Stop code:	(F-30)
USR address:	(F-29)
Location of first byte (lsb):	(F-28)
Locaton of first byte (msb):	(F-27)
Duration:	(F-21)

In normal operation the address of the first frequency data byte is POKEd into (F-28) and (F-27) and a duration value—usually a small number—is POKEd into (F-21). You can imagine the monotonous sound a string of X's (data 61) would make if synthesized so the rest of this article is devoted to filling the frequency data field with meaningful numbers.

DEFMAG Operating Instructions

Whether you use driver A, B, or C, the data encoding procedure is the same. Line 60 of each program applies a formula to the values of I from 0 to 254 to yield a set of numbers ranging in value (but not in sequence) from 0 to 254. Some test formulas are shown in Figure 3 that can be substituted for line 60 in driver program A, B or C.

If you like to work with math, Figures 4 and 5 will enable you to test any formula before applying it. In Figure 4 the formula goes in line 30 and is assigned to the variable A instead of using the POKE command from driver line 60. The plotted waveform is shown.

Figure 5.
Tester program and composite waveform.

```
  10 FAST
  20 FOR I=0 TO 254 STEP 8
  30 LET A=127-INT (127*SIN (I/4
0.155))
  40 PLOT I/4,INT (A/6)
  50 LET A=127-INT (127*COS (I/4
0.155))
  60 PLOT I/4+1,INT (A/6)
  70 NEXT I
```

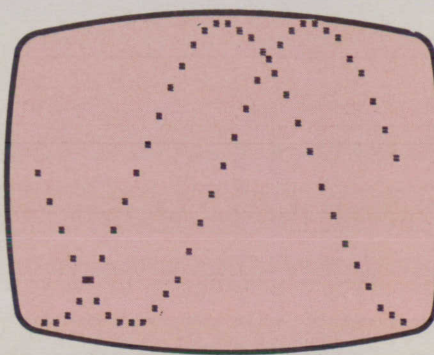


Figure 6.
Combining formulas into Driver A.

```
  10 FAST
  20 LET F=PEEK 16396+256*PEEK 1
6397
  30 POKE F-27,INT ((F-285)/256)
  40 POKE F-28,(F-285)-(INT (((F
-285)/256))*256)
  50 FOR I=0 TO 254 STEP 2
  60 POKE F-285+I,127-INT (127*S
IN (I/40.155))
  65 POKE F-285+I+1,127-INT (127
*COS (I/40.155))
  70 NEXT I
  80 PRINT AT 21,0;"ENTER DURATI
ON"
  90 INPUT Z
 100 POKE F-21,Z
 110 RAND USR (F-29)
 120 GOTO 110
```

Figure 7.
Tester program to display entire data field of any formula.

```
  10 FAST
  20 DIM A$(255,4)
  30 FOR I=0 TO 254
  40 LET A=127-INT (127*SIN (I/4
0.155))
  50 LET A$(I+1)=STR$ A
  60 PRINT A$(I+1);
  70 NEXT I
```

Figure 7a. Data field display for Figure 7.

```
127 124 121 118 115 112 109 105 | 133 137 140 143 146 149 152 155
102 99  96  93  90  87  84  81  | 158 161 164 167 170 173 176 179
78  75  72  70  67  64  61  59  | 182 185 188 191 193 196 199 201
56  53  51  48  46  44  41  39  | 204 206 209 211 213 216 218 220
37  34  32  30  28  26  24  23  | 222 224 226 228 230 232 234 236
21  19  18  16  15  13  12  11  | 237 239 240 242 243 244 245 247
9   8   7   6   5   4   4   3   | 248 249 250 250 251 252 252 253
2   2   2   1   1   1   1   1   | 253 254 254 254 254 254 254 254
1   1   1   1   1   2   2   3   | 254 254 254 253 253 252 251 251
4   4   5   6   7   8   9   10  | 250 249 248 247 246 245 244 242
12  13  14  16  17  19  21  22  | 241 239 238 236 235 233 231 229
24  26  28  30  32  34  36  39  | 227 225 223 221 219 217 214 212
41  43  46  48  51  53  56  58  | 210 207 205 202 200 197 194 192
61  64  66  69  72  75  78  81  | 189 186 183 181 178 175 172 169
84  87  90  93  96  99  102 105 | 166 163 160 157 154 150 147 144
108 111 114 118 121 124 127 130 | 141 138 135 132 128 125 122
```

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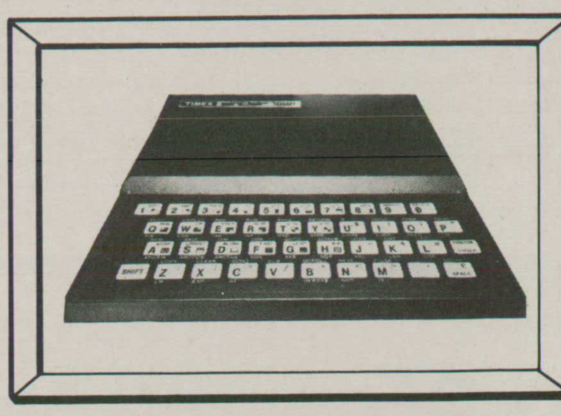

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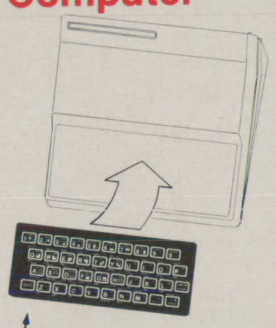

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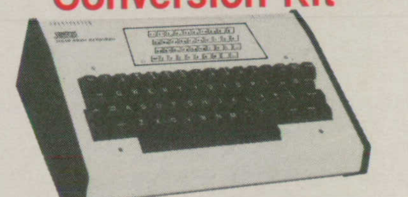

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CIRCLE 39 ON READER SERVICE CARD

It is also possible to plot multiple waveforms using this technique. Figure 5 demonstrates the procedure with the composite waveform. Figure 6 shows how the same formulas are integrated into driver program A.

Figure 7 displays the entire data field generated by any formula. This allows scaling the formula so that it provides positive integers within the proper range. Given I, the set of integers from 0 to 254, and the formula in line 40, the numbers shown in Figure 7 would result. The number of lines is too great to fit on the screen at one time so you will have to use CONT to view the second part of the data field.

Driver Programs

Let us now discuss the specific operation and differences in the driver programs. Enter RUN to operate any of the four drivers. After a brief programming cycle where waveform data is POKEd into the storage area in A and C, the screen prompt asks, "Enter Duration". After entering a value, the sound will be generated (with driver B it is automatic). Driver A operates continuously much like a siren until the loop is exited by pressing BREAK. Driver B operates continuously but with a pseudo-random duration. Driver C plays the tone sequence each time any key except BREAK is pressed.

Driver D operates quite differently from the others. This program responds to any key pressed (except BREAK, SHIFT, [period], and ENTER) by giving a tone. The notes ascend in pitch from 0,1,2,3 . . . 7,8,9,A,B,C . . . X, Y,Z although they are not very evenly tempered. You may experiment with line 90 to improve the pitch. For a repeating trigger, delete lines 110 and 120 and change line 130 to read GOTO 50.

Driver A.

```
  10 FAST
  20 LET F=PEEK 16396+256*PEEK 1
6397
  30 POKE F-27,INT ((F-285)/256)
  40 POKE F-28,(F-285)-(INT (((F
-285)/256))*256)
  50 FOR I=0 TO 254
  60 POKE F-285+I,I
  70 NEXT I
  80 PRINT AT 21,0;"ENTER DURATI
ON"
  90 INPUT Z
 100 POKE F-21,Z
 110 RAND USR (F-29)
 120 GOTO 110
```

Driver B.

```
  10 FAST
  20 LET F=PEEK 16396+256*PEEK 1
6397
  30 POKE F-27,INT ((F-285)/256)
  40 POKE F-28,(F-285)-(INT (((F
-285)/256))*256)
  50 FOR I=0 TO 254
  60 POKE F-285+I,I
  70 NEXT I
  80 FOR I=1 TO 5 STEP 2
  90 POKE F-21,I
 100 RAND USR (F-29)
 110 NEXT I
 120 GOTO 80
```

Driver C.

```
  10 FAST
  20 LET F=PEEK 16396+256*PEEK 1
6397
  30 POKE F-27,INT ((F-285)/256)
  40 POKE F-28,(F-285)-(INT (((F
-285)/256))*256)
  50 FOR I=0 TO 254
  60 POKE F-285+I,I
  70 NEXT I
  80 PRINT AT 21,0;"ENTER DURATI
ON"
  90 INPUT Z
 100 POKE F-21,Z
 110 LET Z$=INKEY$
 120 IF Z$="" THEN GOTO 110
 130 RAND USR (F-29)
 140 GOTO 110
```

Driver D.

```
  10 FAST
  20 LET F=PEEK 16396+256*PEEK 1
6397
  30 POKE F-27,INT ((F-31)/256)
  40 POKE F-28,(F-31)-(INT (((F-
31)/256))*256)
  50 LET Z$=INKEY$
  60 IF Z$="" THEN GOTO 50
  70 LET A=((CODE Z$)-27)
  80 POKE F-21,INT (A*7)
  90 POKE F-31,260-(INT (INT (42
*(INT A*.166667))))
 100 RAND USR (F-29)
 110 LET Z$=INKEY$
 120 IF Z$<>"" THEN GOTO 110
 130 GOTO 60
```

Wind Chimes and the ZX/TS Computer

Carter Scholz

Save time, trial-and-error labor, and materials by calculating the proper length of each chime.

Recently I wanted to build a set of tuned wind chimes. I knew that the calculations involved could become tedious, so I wrote a short program to do them. This program saved me a good deal of time and trial-and-error labor, and it prevented waste of material.

My problem was this: I knew what pitches I wanted, and from those I had to calculate the proper length of each chime. I used cylindrical tubing for lightness, but many other materials would do as well.

A Little Physics

The wave equations for vibrating objects were first put forth by Lord Rayleigh in the nineteenth century, and they are quite complex. Lejaren Hiller, a composer and computer scientist, has programmed them on a large mainframe machine to simulate the sound of "fanciful" or "imaginary" instruments, such as a rubber violin or a piano with glass strings. The ZX81 is not nearly fast enough to do this (no, not even in machine code), but by limiting our options we can simplify Rayleigh's equations and use them to provide parameters for building real instruments.

The behavior of a vibrating object is described mainly by its "boundary conditions." For chimes, we will restrict ourselves to the simple case of free-at-both-ends.

Now, how does the length of the chime relate to its pitch? The simplified expression, in Basic notation, is:

F = 1.133*PI/L**2*SQR(Q*K**2/D)

where F is the frequency in Hertz, L is the length in centimeters, D is the density of the material, Q is Young's modulus for the material, and K is the radius of gyration.

Don't panic. Q and D are easily found (see Table 1), and there is a simple expression for K, which depends on the shape of the vibrating object. For a circular cross-section, e.g., a rod,

K = OR/2

where OR is the radius. For a rectangular cross-section, e.g., a bar,

K = OR/SQR 12

where OR is the thickness in the direction of vibration. For a cylinder, like our wind chimes,

K = SQR(OR**2 + IR**2)/2

where OR is the outer radius and IR is the inner radius of the cylinder.

Solving for L:

L = 1.133*PI*K*SQR(Q/D)

The Program

The complete program is in Listing 1.

The quantity SQR(Q/D) is given a simpler name: S(M). It is dimensioned and assigned in lines 10-30. These lines, and the print lines 50-60, may be expanded to include whatever materials you wish (an assortment is given in Table 1). The display format leaves room for up to eight separate material lines.

After the inputs, the radius of gyration K is calculated for the given shape, and the required length L is calculated and printed. A conversion from centimeters to inches is made (this may be eliminated by deleting all occurrences of the number 2.54 in the program). After the length, the appropriate drill point is printed, and, for tubes, the air resonance. (I will discuss these two factors under "Practical Matters," below.)

Then the program leaps back to line 270 and awaits the next frequency input. It does this so that you do not have to reenter the material and dimensions for every pitch. To exit the program, input STOP; to change materials or dimensions, simply RUN again.

Table 1.

Material	Q (Young's modulus)	D (Density)	S(M) = (Q/D)
Aluminum	6.9E11	2.7	5.06E5
Brass	9E11	8.4	3.27E5
Copper	9.7E11	8.9	3.3E5
Glass	6E11	2.5	4.9E5
Lead	1.7E11	11.3	1.2E5
Oak	*	*	5E5*
Redwood	*	*	2.3E5*
Silver	8E11	10.5	2.8E5
Steel	2E12	7.8	5.06E5

*These values were determined empirically.

Carter Scholz, 2110 Acton #2, Berkeley, CA 94702

You will see that the quantities assigned to S(M) in the program vary somewhat from the values in Table 1. This is to save space, and because the values for real materials will always differ from the ideal. However, no variation here will affect the *relative* tunings of chimes all cut from the same stock, and this is the important thing.

A Little Music Theory

What frequencies to choose? Most commercial wind chimes are cut at random, hence they give random pitches. But you do not need a program to do that. So here is some short, painless music theory to help you choose your pitches.

Ptolemy observed that when two pitches sound at once, they are pleasing in proportion to their frequency ratios. A unison (ratio of 1/1) is the most pleasing, or consonant, interval. An octave (ratio 2/1) is also quite consonant. A perfect fifth (3/2), a perfect fourth (4/3), and a major third (5/4), are all revered as "pleasing" intervals. They sound "in tune" with one another. And most small-number ratios have this property. So as long as you select small-number ratios (e.g., 5/3, 6/5, 7/4, 9/8), your chimes will sound "tuned."

First, pick a base frequency as your 1/1—say, between 400 and 800 Hertz—and then pick some simple ratios above it. I built a set of six chimes, using a common denominator: 6/6, 7/6, 8/6, 9/6, 10/6, 12/6. You will see that 12/6 = 2/1, an octave; the use of the octave is especially pleasing.

A "pentatonic scale" is also lovely: 1/1, 9/8, 5/4, 3/2, 5/3, 2/1. But, by all means, experiment!

"Well... I guess that program wasn't compatible with my computer!"

Frequencies for the piano octave above middle C are given in Table 2; for other octaves, divide or multiply these frequencies by powers of two. The third column of Table 2 gives the approximate

Table 2.

C	262	(1/1)	unison
C#	277	(16/15)	minor 2nd
D	294	(9/8)	major 2nd
D#	311	(6/5)	minor 3rd
E	330	(5/4)	major 3rd
F	349	(4/3)	perfect 4th
F#	370	(10/7)	tritone
G	392	(3/2)	perfect 5th
G#	415	(8/5)	minor 6th
A	440	(5/3)	major 6th
A#	466	(7/4)	minor 7th
B	494	(15/8)	major 7th
C	523	(2/1)	octave

small-number ratios for intervals above middle C; they are not exact because contemporary tunings are not mathematically rational. The last column gives interval names.

Practical Matters

All the chimes should probably be between about eight and about twenty inches in length. I used 1" aluminum tubing with a wall thickness of .055". If the tubes are too long or too short, the

You can use the same equations for a marimaphone, xylophone, or vibraphone, using bars or tubes.

sound of inharmonic overtones from the metal begins to spoil the pure tuned sound. And *each chime must be hung from a point 22.42% down its length,* so to reduce those inharmonic overtones. Just cut one tube and try striking it while holding it at various points, and you will hear what I mean.

The "air resonance" is less important, but it will to some extent emphasize or dampen the frequency you want, so it is given in program lines 350-360. If the air resonance has an integral multiple within about 10% of the desired frequency, the tone will be somewhat enhanced. The ease of calculating with the program enables you to try many variations of dimension effortlessly.

After the tubes are cut, you can sharpen (increase) their pitch by filing one end. Aluminum will take a gorgeous shine if you buff it with fine steel wool around the tube (not up and down). The framework and striker are up to you; but keep the tubes far enough apart so they do not clang against each other in a strong wind.

Further . . .

The same equations can be used to design a marimaphone, xylophone, or vibraphone, using bars or tubes. Again, mount the bars or tubes at holes drilled 22.42% from each end. Some of these instruments use resonators mounted beneath the sounding element to amplify the sound. (2″ ABS pipe is a good cheap material for the resonators.) The length, in inches, of an appropriate resonator is:

$$L = 3390/F - .29*D$$

where F is the desired frequency in Hertz, and D is the inner diameter of the resonator in inches.

However, if you get seriously interested in instrument design, there are many, many refinements. I suggest Banek and Scoville's *Sound Designs* (Ten Speed Press) as a primer, and Harry Partch's *Genesis of a Music* (Da Capo Press) as a graduate course in the design and construction of instruments. Have fun!

List of Variables:

N: Number of materials; if you expand the list, change this variable accordingly.
M: Index of material in array S(M).
D: Diameter of rod or cylinder, or thickness of bar, in inches.
T: Thickness of cylinder, in inches.
K: Radius of gyration.
F: Frequency, in Hertz.
L: Length, in inches.
S(M): Array containing values for various materials.

Line Notes:

10-70: Sets up material constants (see Table 1). Up to eight separate material lines may be accommodated by the screen format.
80: Graphics >
140: Graphics > ■

```
MATERIAL?
■. ALUMINUM/STEEL/GLASS
2. BRASS/COPPER

SHAPE?
1. CIRCULAR (ROD)
2. RECTANGULAR (BAR)
■. CYLINDRICAL

DIAMETER? 1
THICKNESS OF CYLINDER? .055

FREQUENCY? 660

LENGTH=19.109317 INCHES
DRILL AT 4.2843088 INCHES
AIR RESONANCE AT MULTIPLES OF
174.74842 HZ
```

Listing 1.

```
  5 LET N=4
 10 DIM S(2)
 20 LET S(1)=5E5
 30 LET S(2)=3.3E5
 40 PRINT "MATERIAL?"
 50 PRINT "1. ALUMINUM/STEEL/GL
ASS"
 60 PRINT "2. BRASS/COPPER"
 70 INPUT M
 80 PRINT AT M,0;"■";AT N,0;
 90 PRINT "SHAPE?"
100 PRINT "1. CIRCULAR (ROD)"
110 PRINT "2. RECTANGULAR (BAR)
"
120 PRINT "3. CYLINDRICAL"
130 INPUT S
140 PRINT AT S+N,0;"■";AT 9,0;
150 IF S<>2 THEN PRINT "DIAMETE
R? ";
160 IF S=2 THEN PRINT "THICKNES
S OF BAR? ";
170 INPUT D
180 PRINT D
190 LET K=D/4*2.54
200 IF S=1 THEN GOTO 270
210 LET K=D/SQR 12*2.54
220 IF S=2 THEN GOTO 270
230 PRINT "THICKNESS OF CYLINDE
R? ";
240 INPUT T
250 PRINT T
260 LET K=SQR (D*D+(D-T)*(D-T))
/4*2.54
270 PRINT AT 12,0;"FREQUENCY? "
;
280 INPUT F
290 PRINT F
300 LET L=SQR (1.133*PI*K*S(M)/
F)/2.54
310 PRINT
320 PRINT "LENGTH=";L;" INCHES"
330 PRINT "DRILL AT ";L*.2242;"
INCHES  "
340 IF S<>3 THEN GOTO 270
350 PRINT "AIR RESONANCE AT MUL
TIPLES OF"
360 PRINT 3390/(L+.29*D);" HZ"
370 GOTO 270
```

The Fantastic Music Machine and Light Show

Susan E. Harris

The Fantastic Music Machine is a unique program that transforms your computer keyboard into a 3-octave musical instrument with reasonably good tonal quality with 16K it can handle up to 7000 notes.

I approached this program with a very skeptical attitude. After all, how fantastic a music machine was possible on a $9.95 cassette? To say I was surprised is an understatement. This package really is fantastic!

The manual takes you through the art of composing music, right down to sharps and flats, reading musical manuscripts, and transferring them to the computer, writing music via score sheets, editing, and a basic understanding of musical notation. You do not have to be familiar with musical notation to use this package, but it is certainly helpful. The average person, supplied only with the excellent instructions, can begin making music in a few minutes.

Once the program is loaded, the keyboard is under program control. Each key represents a musical note or a special function shown on the keyboard overlay. Each of the top three rows starts and ends with a C note but in a different octave.

Another interesting feature of the program is that, as you press a musical note key, the screen displays lines similar to the LOADing lines. I found this helpful in composing and in editing.

The music is played through a TV receiver or a radio situated nearby. I tried it both ways and found the sound through my TV satisfactory. The tonal quality was quite good, and it can be adjusted higher or lower. It is also possible to change the tempo and cause the pitch of individual notes to rise or drop. A myriad of strange noises can be created by the special effects function.

When you have completed writing or transferring a piece of music, you can record and play back the results.

This package is a more complex and much more versatile version of *Composer*, originally designed for 1K and up to 400 notes, expanded to 16K and up to 7000 notes.

I decided to transfer a musical piece from manuscript to the computer. Within an hour I completed the entire piece and was able to play it back. I discovered a few errors in my input, but with the editing function I could go backward and forward through the data at will and make the necessary changes in about 10 minutes. I then replayed the piece and was pleased with the results.

The Fantastic Music Machine is the type of package that will wear out long before you lose interest. The uses are almost endless. Young and old alike will delight in playing with it, and the educational aspects are appealing as well.

The *Light Show* is a unique program that creates kaleidoscopic patterns which continue indefinitely until you press the ENTER key. The printer will capture the pattern in copy.

Using the menu options, you can go back to simply viewing the ever-changing display, or you can create your own repeating patterns. The patterns change almost instantaneously and the designs produced are entirely random. You can come up with some rather outrageous designs which can be SAVEd.

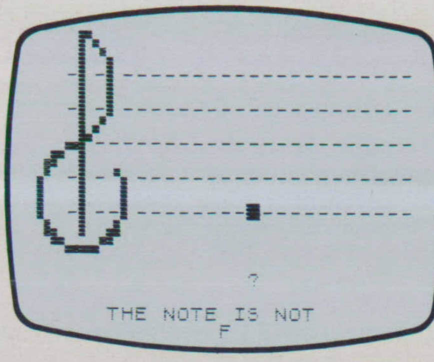
Simulsion offers a sophisticated and highly entertaining line of software, and this new offering is well worth the price.

SYNC
SOFTWARE PROFILE
Name: The Fantastic Music Machine
Light Show
Type: Music composer
Graphics display
System: 8K ROM; 16K RAM
Format: Cassette
Summary: This package of two programs really is fantastic!
Price: $9.95
Manufacturer:
Simulsion
Box 894
Lemon Grove, CA 92045

Susan E. Harris, S. E. Harris Associates, 310 Lee St., Strasburg, VA 22657.

Staff: Teacher and Tester

Sharon Zardetto Aker



The ability to name notes on the staff is a necessary skill for even the novice musician. "Staff" is a versatile music education program that reviews notes from the first ledger line below the staff to the first ledger line above. Although the program includes the necessary lines for use with the ZON X-81 sound generator, it can be an effective educational program even without sound.

The basic program is in "tester" mode. It will put a note somewhere on the treble staff and wait for you to enter the letter name of the note. It will acknowledge the right answer, and, in the ZON version, play the note. If you do not enter the correct note in three tries, the computer will give the answer, play the note, and go on to the next note. Twenty random notes are presented.

Variations on a Theme

"Staff" is easily edited to the "teacher" mode which presents, plays, and identifies in order from the lowest to the highest notes. The range is covered three times.

Another variation, used with either the teacher or tester mode, uses the bass clef. Any of the four resulting programs can be used with or without the ZON unit.

Variables

C: Register contents (ZON)
D: Register number (ZON)
R: Round counter
N: Note placement (display line number)
V: Check for odd/even display line
Z: Guess counter
G$: Note guessed
A$: Name of note
T: Counter for loop timing

Sharon Zardetto Aker, 20 Courtland Dr., Sussex, NJ 07461.

The tester mode puts a note somewhere on the treble staff and waits for you to enter the letter name.

Line Notes

The program line notes are presented in two parts: one for the general program and one for the ZON programming. Necessary changes for the program variations are indicated after the line notes. The ZON version is necessarily set up for automatic RUN on LOADing; in order to SAVE the program, enter RUN 5.

ZON notes

1: Machine code loading routine.

3: Loads registers with preparatory values (see subroutine).

107: Channel A tuner.

115, 125: Sets note frequency.

130: Loads note.

131, 132: Single decay envelope.

134: Turns on sound.

200-215: Clear all registers.

220-250: String slicing routine loads registers 7, 8, and 12 to enable channel A tone, enable the envelope, and set envelope period.

260-275: Adjunct to loading routine in initial REM.

General notes

10-25: Draw staff.

30-70: Draw clef.

85: Places note (inverse space) on staff, with or without ledger lines.

90: Checks for display line number of notes; all odd numbers are notes in spaces; even numbers are notes on lines. V will represent odd; NOT V, even.

110, 120: A$ assignment according to placement of note. Since all values in the logical statement are evaluated, splitting the possibilities into two IF-THENs speeds the running of the program.

140: Acknowledges a right or wrong answer; identifies note after third wrong guess.

145: 16 spaces, 2 commas, 1 space.

155: Erases note, replacing staff line where necessary. Last parenthetical statement has three spaces between the quotation marks.

Variations

The following variations may be developed by editing as indicated.

1) Non-ZON

Delete lines 1-9, 107, 115, 125, 130, 131, 132, 134, and all lines from 200 on.

Add:

5 REM "STAFF"

and SAVE the program in the usual way.

Other variations include ZON program lines; delete as necessary.

2) Teacher mode

Delete lines 95, 100, 105, 150.

Change/add:

```
 75 FOR R=1 TO 3
 80 FOR N=16 TO 4 STEP -1
130 GOSUB 260        (ZON)
134 GOSUB 260        (ZON)
140 PRINT AT N,31;A$
145 PRINT AT N,31;" "
158 NEXT N
```

3) Bass staff

ZON programmers will notice that the notes, although in the correct relationship to each other, are not the correct fre-

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CIRCLE 71 ON READER SERVICE CARD

quency for pitch or octave. This is because the lower notes need a C value larger than 255, with a load into register D1, a routine that does not fit simply into this particular program. Changing the value of C in lines 115 and 125 and adding a subroutine for the second load will give the lower octaves.

To draw the bass clef, replace lines 30-70 with:

```
 30 FOR X=9 TO 10
 35 PLOT X,25
 36 PLOT X,26
 37 NEXT X
 40 FOR V=1.6*PI TO 2.7*PI STEP
PI/20
 45 PLOT 14+6*SIN V,25+6*COS V
 50 NEXT V
 55 FOR X=18 TO 13 STEP -1
 60 PLOT X,X+3
 65 NEXT X
 69 PLOT 23,24
 70 PLOT 23,28
```

Change/Add:

```
 110 IF V THEN LET A$=("B" AND N
=5)+("G" AND N=7)+("E" AND N+9)+
("C" AND N=11)+("A" AND N=13)+("
F" AND N=15)
*115 IF V THEN LET C=(89 AND N=5
)+(110 AND N=7)+(126 AND N=9)+(1
68 AND N=11)+(199 AND N=13)+(242
 AND N=15)
 120 IF NOT V THEN LET A$=("C" A
ND N=4)+("A" AND N=6)+("F" AND N
=8)+("D" AND N=10)+("B" AND N=12
)+("G" AND N=14)+("E" AND N=16)
*125 IF NOT V THEN LET C=(84 AND
 N=4)+(100 AND N=6)+(121 AND N=8
)+(147 AND N=10)+(178 AND N=12)+
(220 AND N=14)+(252 AND N=16)
```

* Denotes ZON line.

Listing 1.

```
   1 REM YYPEEK TO YYPEEK ?TAN
   2 FAST
   3 GOSUB 200
   4 GOTO 9
   5 SAVE "STAFF"
   6 GOTO 1
   7 REM STAFF-MUSIC ED.
   8 REM ZARDETTO AKER
   9 SLOW
  10 LET A$="------------------
------"
  15 FOR I=6 TO 15 STEP 2
  20 PRINT AT I,5;A$
  25 NEXT I
  30 FOR Y=12 TO 34
  35 PLOT 12,Y
  40 NEXT Y
  45 FOR V=0 TO PI STEP PI/20
  50 PLOT 12+4*SIN V,29+6*COS V
  55 NEXT V
  60 FOR V=.5*PI TO 2.2*PI STEP
PI/20
  65 PLOT 12+6*COS V,16+6*SIN V
  70 NEXT V
  75 FOR R=1 TO 20
  80 LET N=INT (RND*13+4)
  85 PRINT AT N,18;("■" AND N>4
AND N<16)+("-■-" AND (N=4 OR N=1
6))
  90 LET V=N/2-INT (N/2)
  95 FOR Z=1 TO 3
 100 PRINT AT 18,18;"?"
 105 INPUT G$
 107 LET D=0
 110 IF V THEN LET A$=("G" AND N
=5)+("E" AND N=7)+("C" AND N=9)+
("A" AND N=11)+("F" AND N=13)+("
D" AND N=15)
 115 IF V THEN LET C=(68 AND N=5
)+(81 AND N=7)+(98 AND N=9)+(121
 AND N=11)+(153 AND N=13)+(177 A
ND N=15)
 120 IF NOT V THEN LET A$=("A" A
ND N=4)+("F" AND N=6)+("D" AND N
=8)+("B" AND N=10)+("G" AND N=12
)+("E" AND N=14)+("C" AND N=16)
 125 IF NOT V THEN LET C=(61 AND
 N=4)+(77 AND N=6)+(89 AND N=8)+
(105 AND N=10)+(137 AND N=12)+(1
61 AND N=14)+(195 AND N=16)
 130 IF A$=G$ OR Z=3 THEN GOSUB
260
 131 LET C=0
 132 LET D=13
 134 IF A$=G$ OR Z=3 THEN GOSUB
260
 140 PRINT AT 20,8;"THE NOTE IS"
+(" NOT" AND A$<>G$ AND Z<3),,(A
$ AND (A$=G$ OR Z=3))+(G$ AND G$
<>A$ AND Z<3)
 142 PAUSE 120
 145 PRINT AT 20,8;"
    ",,"  "
 150 IF A$<>G$ THEN NEXT Z
 155 PRINT AT 18,18;" ";AT N,18;
(" " AND N>4 AND N<16 AND V)+("-
" AND N>4 AND N<16 AND NOT V)+("
   " AND (N=4 OR N=16))
 160 NEXT R
 165 PRINT AT 18,6;"THAT IS ALL
FOR NOW"
 170 STOP
 200 LET C=0
 205 FOR D=1 TO 11
 210 GOSUB 260
 215 NEXT D
 220 LET D$="076208161230"
 225 LET D=VAL D$( TO 2)
 230 LET C=VAL D$(3 TO 4)
 235 GOSUB 260
 240 IF LEN D$=4 THEN RETURN
 245 LET D$=D$(5 TO )
 250 GOTO 225
 260 POKE 16515,D
 265 POKE 16519,C
 270 LET X=USR 16514
 275 RETURN
```

Making Music with the ZON X-81

Sharon Zardetto Aker

Add some appropriate music to your game programs with the ZON X-81.

Programming the ZON, Bi-Pak's sound generator, to play a simple tune is no simple task. On the other hand, it is far from impossible, and this article should be of help to aspiring computer musicians.

Channel Tuning

Although many ZON registers are involved in programming a melody, the most confusing to deal with are the tuning registers. There are three difficulties involved: finding the correct frequency, determining its load value, and the actual loading process.

While the ZON manual gives the frequency of middle C and an impressive formula that will give you the load value from a frequency, you may be at a loss for any note other than C. To find the values you need, there are three things you must know about music theory:

1) If the frequency of a note is doubled, or halved, the note changes by an octave.

2) There are 12 semitones, or halftones, available from any note to its octave.

3) The pattern of tones needed for a major scale (the familiar DO-RE-MI pattern) is: whole tone, whole tone, half tone, whole, whole, whole, half. Together with the starting note, that makes eight tones in the scale—an octave. The tones found in a scale are more likely to be together in a song.

The key to programming ZON notes is this: forget about frequencies and work directly with load values.

The load value for middle C is 388. In music, doubling a frequency raises the note an octave, but the ZON works in reverse: 194 is the load value for the next higher C. Dividing this range (from middle C to its octave) into twelve equal portions gives the figures in Chart 1.

Chart 1. Note load values.

Note Name	Load Value
C	194
B	210
A#/B^b	226
A	242
G#/A^b	258
G	274
F#/G^b	291
F	306
E	322
D#/E^b	338
D	354
C#/D^b	371
middle C	388

Chart 2. Loading the tuning registers.

Load Value	Second Register	First Register
972	3	204
738	2	226
342	1	86
289	1	33
179	0	179

The notes with no sharps or flats (see Chart 1) are the ones needed to get a C major scale—the DO-RE-MI pattern beginning on the note C. You can derive any other note you need by finding its octave from this chart: the G below middle C would be (274*2), while E above this scale is (322/2). You may find it necessary to make some adjustments to some of the load values for just the right pitch, because the fractional values that were rounded for this scale will be multiplied in another octave. Let your ears be your guide.

Loading the Values

Each channel has two tuning registers, referred to in the manual inaccurately as rough and fine tuning. The lower numbered register of each pair (D0, D2, and D4) cannot hold a number higher than 255. Higher values must be split between the two tuning registers, and, while the second register of each pair (D1, D3, D5) can only hold a number up to 16, that number represents a *multiple* of 256.

To tune channel A for an F, registers D0 and D1 must be loaded with a total of 308. D1 will hold the multiples of 256, in this case, 308/256, or 1. The remainder, 42, is put into register D0. See Chart 2 for other examples of loading values into the tuning registers.

Programming a Tune

A number of other registers must be attended to in order to make the ZON play a tune. The remainder of this article traces the programming required to play a short piece of music that might be apropriate for the beginning of a new game program. The melody is from the opening bars of *Also Sprach Zarathustra,* better known as the theme from *2001: A Space Odyssey*. The techniques used in the development of this program will have many other applications.

Sharon Zardetto Aker, 20 Courtland Dr., Sussex, NJ 07461

Planning the Notes

The melody in this program consists of three single notes (C, G, and octave C) followed by two chords (C major and C minor). Because both chords have two notes in common with the original single notes, it is only necessary to change the tuning of one channel. Chart 3 shows which notes will be played by which channel. Channel A will be re-tuned for E and $E\flat$ because the lower C that it was playing is not needed in the chord.

As each of the single notes is played, the channel tuned to the preceding note has to be turned off, or both notes will sound. This, and other programming points, are best covered in a line-by-line explanation of the accompanying listing. In the text, ZON registers and their contents are referred to parenthetically as (D,C), where D is the register and C is its contents.

Chart 3.

Channel	Single Note	C Major	C Minor
A	C	E	E^b
B	G	G	G
C	C	C	C

Listing 1.

```
  1 REM YYPEEK TO YYPEEK ?TAN
  2 GOTO 10
  3 POKE 16515,D
  4 POKE 16519,C
  5 LET X=USR 16514
  6 RETURN
  7 REM ZARDETTO AKER
  8 SAVE "2001"
  9 GOTO 1
 10 FAST
 11 LET C=0
 13 FOR D=1 TO 11
 15 GOSUB 3
 17 NEXT D
 18 LET A$="07560816091610161222
5"
 20 LET D=VAL A$( TO 2)
 22 LET C=VAL A$(3 TO 4)
 24 GOSUB 3
 26 LET A$=A$(5 TO )
 28 IF A$<>"" THEN GOTO 20
 29 SLOW
 30 LET D=0
 31 LET C=252
 32 GOSUB 3
 35 LET D=13
 36 LET C=0
 37 GOSUB 3
 38 GOSUB 100
 40 LET D=8
 41 LET C=0
 42 GOSUB 3
 45 LET D=2
 46 LET C=166
 47 GOSUB 3
 50 LET D=13
 51 LET C=0
 52 GOSUB 3
 53 GOSUB 100
 55 LET D=9
 56 LET C=0
 57 GOSUB 3
 60 LET D=4
 61 LET C=126
 62 GOSUB 3
 65 LET D=13
 66 LET C=0
 67 GOSUB 3
 68 GOSUB 100
 70 LET D=10
 71 LET C=0
 72 GOSUB 3
 75 LET D=0
 76 LET C=100
 77 GOSUB 3
 80 LET C=16
 81 FOR D=8 TO 10
 82 GOSUB 3
 83 NEXT D
 85 LET D=12
 86 LET C=60
 87 GOSUB 3
 90 LET D=13
 91 LET C=0
 92 GOSUB 3
 95 LET D=0
 96 LET C=107
 97 GOSUB 3
 99 STOP
100 FOR T=1 TO 15
102 NEXT T
103 RETURN
```

Program Line Notes

1-6: ZON loading routine.

10-16: Clear all registers.

18-28: A string-slicing routine that saves program space and typing many LET statements. The computer looks at four digits at a time, the first two being the register number and the next two the contents. String slicing is a little slower than using LET statements, but is appropriate for setting up some of the registers at the beginning of the program. This routine enables tone on all three channels (7,56), enables envelopes (8-10,16), and sets the duration of the note (12,25).

30-42: Tune channel A (0,252), play the note (13,0), and turn off the note by changing the volume (8,0). The subroutine for a delay loop is necessary because otherwise the note will be turned off before it has faded. Not only will the duration then be shorter than planned, but the tone will have an unwanted "chopped off" sound.

45-72: Tune, play, and shut off the notes in channels B and C.

75-77: Tune channel A to E.

80-83: Turn volume back on for all channels.

85-87: Increase duration of notes.

90-92: Play chord. All three channels are tuned and turned on. Channels B and C retain their original tuning.

95-97: Re-tunes channel A to E. This is done while the chord is still playing, and the change is heard immediately.

This program was written to be run in SLOW mode so it will not interfere with an introductory display. If you want to run it in FAST, you will find it necessary to change the duration of the notes (register 12) and the T value in the delay loop. Also, when running this type of program in FAST, repeated loads to register 13 to get the note to play are not always necessary.

If you wish to program the second strain of this theme, it is the same as the first, except that the C major and C minor chords are switched at the end. ■

FOR SINCLAIR AND TIMEX SINCLAIR OWNERS ONLY

If you own a Timex Sinclair, a ZX81, or any other Sinclair computer, you've probably discovered that the big microcomputer magazines cover only the bigger computers. Where can you find helpful articles on the Sinclair? In *Sync!*

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Say What? *Brad Bennett*

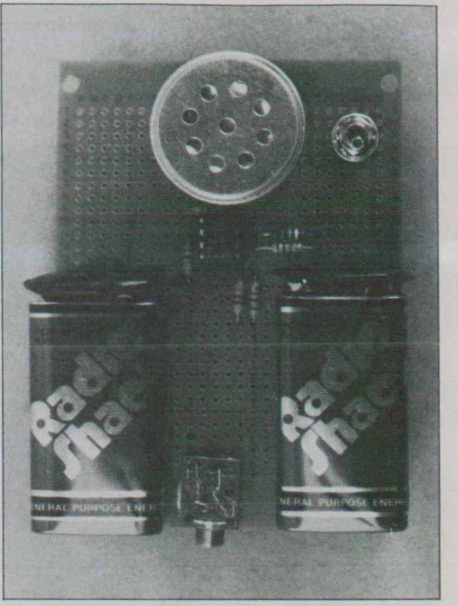


Photo 1. Prototype.

You have just completed entering a program containing almost 1,000 statements, yet during all that programming your fingers never touched a keyboard. Anticipating the best, you lean back in your chair and with a single spoken command you see what an evening's worth of effort will bring. "RUN" you command . . . and RUN the program does.

Is this scenario a dream? Hardly. Take a look through any current technology related publication and you are likely to come across an article or advertisement concerning speech recognition. It is a technology which offers an alternative to the normal human-machine interface consisting of direct physical contact. Today you flip a switch, press a key, and turn a dial. Tomorrow you may only have to speak the command to perform these tasks.

But back to today, and in particular to the subject of this article: a simple speech recognition program for ZX/TS computers (with at least 16K RAM). The word "simple" should be emphasized. The program is relatively simple to enter and run. It is limited to recognizing only ten simple words (but ten words of your choice!). It is not designed to replace your keyboard (sorry), rather it is an experimental tool. With consistent pronounciation the program will recognize and display the correct word approximately 9 out of 10 times. Not bad . . . but I hope not to hear from someone who has interfaced the system to control the brake and accelerator in his automobile!

The speech recognition program has three major parts:

1) A speech input routine. This displays a "voice print" in the form of a histogram, and is actually a pseudo frequency spectrum of a vocalized word or sound.

2) A file system. Up to ten separate voice prints along with the corresponding word (string) are stored. These voice prints and strings are employed during speech recognition for comparison.

3) A speech recognition routine. This compares a newly spoken voice print to the prints stored in the file. A string corresponding to the best matching voice print entry is then displayed on the TV screen.

Each of these three parts consists of Basic statements with calls to appropriate machine code routines when fast and efficient program execution is required.

Brad Bennett, Advanced Interface Designs, PO Box 1350, State College, PA 16801

Hardware

To use the program, a small piece of hardware must be constructed. This provides an amplified voice signal to the computer's ear input. Parts for the board can be readily obtained at most Radio Shack stores and G. Russell Electronics. Even for those with limited construction experience, assembly should take no more than a couple of hours.

Step by Step Construction

A complete parts list and required tools are given in Table 1.

Table 1. Amplifier part and tool list.

Qty	Description	Radio Shack Part No.
1	Experimenter's Grid Board	276-158
1	Crystal Mike Element	270-088
1	8 Pin Low Profile Socket	276-1995
1	3 Conductor Mini Jack	274-249
1	TL 081 Single BiFET OP AMP	276-1716
	or	
1	TL 091 Single N-FET Op AMP	276-1745
1	DPDT Micro Miniature Toggle Switch	275-626
2	9 Volt Battery Snaps	270-325
2	9 Volt Battery	23-464
1	10 Meg Ohm resistor $\frac{1}{4}$ watt .5%	271-1365
3	10 K Ohm resistor $\frac{1}{4}$ watt .5%	271-1335
1	1 K Ohm resistor $\frac{1}{4}$ watt .5%	271-1321
1	470 K resistor $\frac{1}{4}$ watt .5%	271-1354

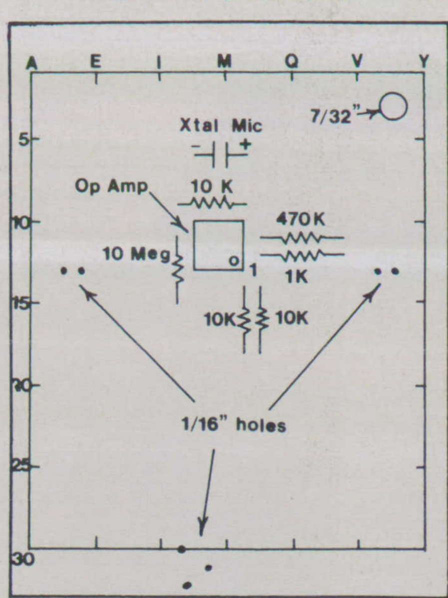
Miscellaneous

3 feet of 22 gauge (or smaller) single conductor wire Rosin core solder

Tools

1) 25-40 Watt Soldering Iron
2) Diagonal Wire Cutters
3) Needle Nose Pliers
4) Electric or Hand Drill
5) $\frac{7}{32}$" Drill Bit
6) $\frac{1}{16}$" Drill Bit

Figure 1. Component layout.



1) Lay out the board. Photo 1 shows our prototype. We found this configuration comfortable to hold in the palm of a hand. Component layout is given in Figure 1 (Note: the copper pad side of the grid board is down).

2) Drill a $\frac{7}{32}$" hole for the DPDT power switch at hole W-3 (W-3 are grid board coordinates). With the $\frac{1}{16}$" drill bit, enlarge the holes at positions C-13, D-13, V-13, and W-13 to allow the battery snap leads to pass. Also with the $\frac{1}{16}$" drill bit, enlarge the hole at J-30 and drill two new holes to accommodate the 3 conductor mini lack. Make sure the threaded portion of the jack extends past the board edge so that the cassette cable mini plug can be fully inserted.

3) Install the DPDT switch in the $\frac{7}{32}$" hole with the supplied hardware.

4) Install the 3 conductor mini jack into the proper holes. A small amount of silicon rubber sealer (or other available adhesive) will help to fix the jack onto the board. Solder the jack terminal at hole J-30 to its respective pad.

5) Solder a $1\frac{1}{2}$" piece of the 22 gauge single conductor wire to each of the crystal mike element terminals. Bend these wires perpendicular to the element, and insert the (-) terminal lead in hole K-6 and (+) terminal lead in hole N-6. Solder these wires to their respective pads. Let the excess wire remain unconnected temporarily.

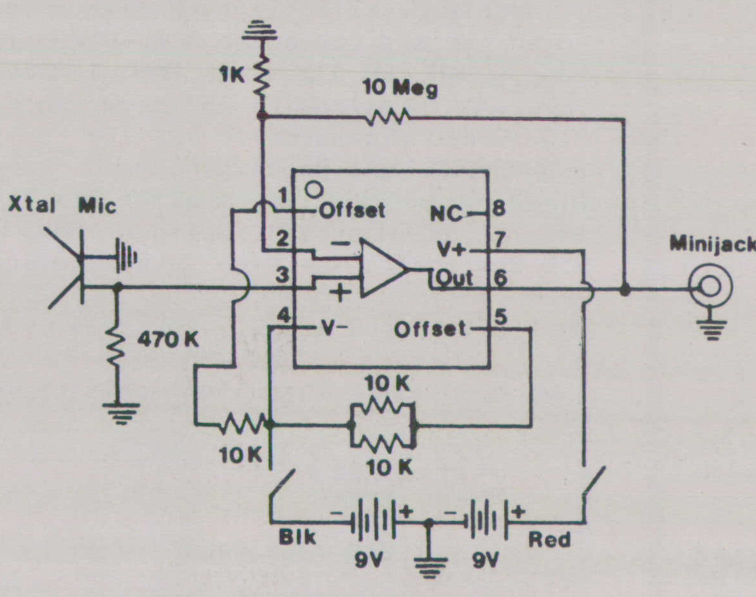
6) Insert the 8 pin IC socket into the board. The socket should occupy holes K-10 through K-13 and holes N-10 through N-13. Pin 1 is located at hole N-13; pin 8 is located at hole K-13. After insertion, bend the leads of the socket outward to hold it in place. *Do not install the OP AMP at this time.*

7) Insert resistor leads as in Table 2. After positioning a resistor, solder the protruding lead to its respective pad.

8) Bend the leads of the resistors to make the required connection(s). See Figure 2. Solder where necessary. As a check for completeness, trace over the schematic with high lighting pen after each connection has been made. Photo 2 shows the prototype backside.

9) Wire the connections to the mini jack. Connect IC socket pin 6 (hole K-11) to the jack terminal extending through hole J-30. This is the amplifier output. It must be connected to the jack terminal which makes contact with the tip of the cassette cable plug. Connect either of the other two jack terminals to ground.

Figure 2. Amplifier schematic.



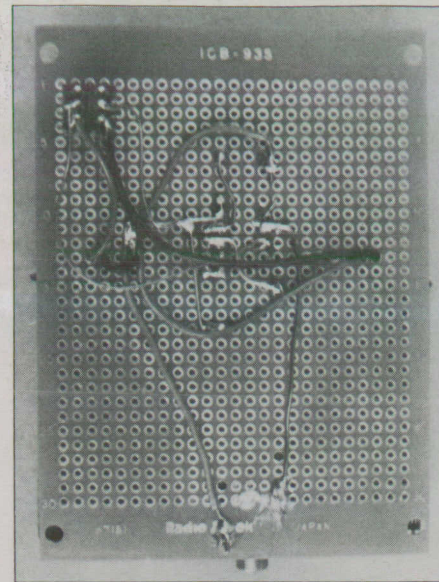


Photo 2. Backside of prototype.

Table 2. Resistors and locations.

Resistor	Board Location
10K Ohm (Brn Blk Org)	J-9, N-9
10 K Ohm	N-14, N-18
10 K Ohm	O-14, O-18
10 Med Ohm (Brn Blk Blu)	J-11, J-15
1 K Ohm (Brn Blk Red)	O-12, T-12
470 K Ohm (Ye) Vio Yel)	0-11, T-11

10) Complete the circuit by wiring the battery and switch leads. Ground is established by tying and soldering together the black lead of the right side battery snap (hole V-13) with the red lead of the left side battery snap (hole D-13). Solder this junction to the resistor leads extending through holes T-11 and T-12. The ground lead of the crystal mike (hole K-6) is also connected to this point. With a piece of the 22 gauge wire, connect one of the mini jack ground terminals to the same ground junction.

11) Connect and solder the remaining red and black battery snap leads to the lower two switch terminals. Solder a 2" wire to each of the two center terminals of the switch. Taking note of the proper wire, solder the wire which makes contact through the switch with the red battery lead to IC socket pin 7 (V+). Solder the other center switch terminal wire to IC socket pin 4 (V-).

12) Install the op amp. The recessed dot on top of the op amp indicates pin 1, and should be away from the crystal mike element (approximately lined up with hole N-13).

13) Finally, making sure the DPDT switch is off (lever down), clip on the two 9 volt batteries to the battery snaps.

This completes amplifier board assembly.

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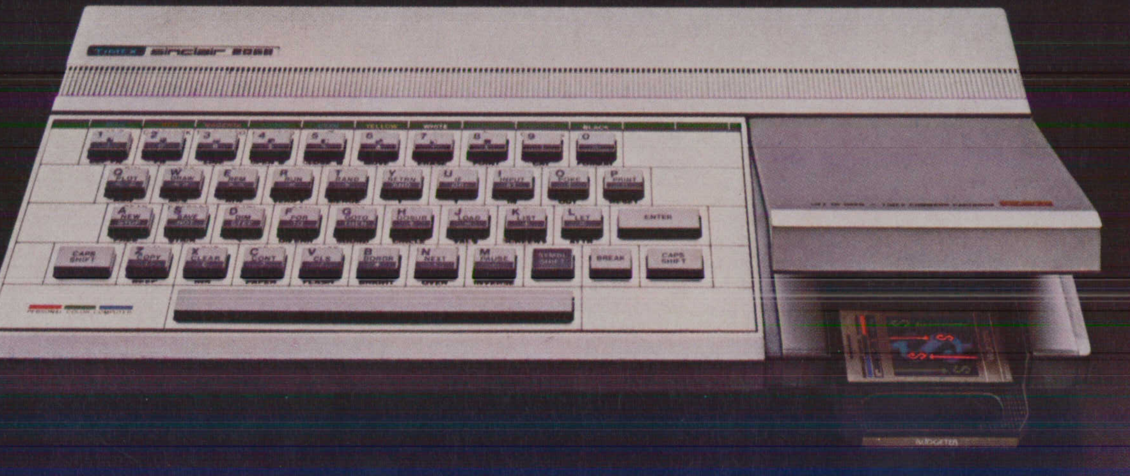
72K COLOR SOUND UNDER $200



TIMEX SINCLAIR 2068

CIRCLE 64 ON READER SERVICE CARD

Listing 1. Speech Recognition Program.

```
   1 REM        5 ? COPY Q  7TAB
 RND  COPY 5 ?: RETURN GOSUB ?
PAUSE RNDG GOSUB ? IF RNDO COS
 GOSUB ? IF RNDI )>= COPY .?CO
5 GOSUB ? PAUSE RND?RND5 ?: 2R
NDLN INT RND7£14 SAVE TAN YF?VA
L STR$ FAST LN " LPRINT SGN AT
TAB OR RNDTAN RND5?U? ?) ?ST
R$ ) ;SGN ,?< 4 POKE TAN C?5?
LN AINKEY$? Y?4 PRINT U? RND
5??X4 UNPLOT )C? FOR GOSUB TAN
 VAL Y   ) ? FOR  FOR X74 SAV
E ACS ,ACS . 4 SAVE AT TAN 5
? COPY  VAL ) ?: RND, K JW K Y
 COPY ?7< 4 LOAD ?AT M**?K ??M
? Y 4USR TAN 5RND  INPUT 7 4
 CLS ?TAN                     P
   5 IF USR 16758<>64 THEN PRINT
 AT 10,10;"BAD LOAD"
  10 DIM C(1)
  15 DIM T$(10,10)
  20 CLS
  25 PRINT AT 7,1
  30 PRINT TAB 12;"MENU",,
  35 PRINT TAB 6;"1. VOICEPRINT
DISPLAY"
  40 PRINT TAB 6;"2. VOICEPRINT
FILE"
  45 PRINT TAB 6;"3. RECOGNITION
"
  50 PRINT TAB 6;"4. CLEAR FILES
"
  55 PRINT TAB 6;"5. DISPLAY STR
ING FILE"
  60 PRINT TAB 6;"6. STOP"
  62 PRINT ,,,,,,TAB 8;"INPUT SE
LECTION"
  65 FAST
  70 INPUT S
  75 IF S<=6 THEN GOTO S*200
  80 GOTO 70
 199 REM **VOICEPRINT DISPLAY***
 200 RAND USR 16520
 205 LET K=22528
 210 CLS
 215 POKE 16577,INT (K/256)
 220 POKE 16576,K-256*INT (K/256
)
 225 RAND USR 16575
 230 PRINT AT 2,20;"AGAIN? (Y/N)
"
 235 SLOW
 240 IF INKEY$="" THEN GOTO 240
 245 FAST
 250 LET B$=INKEY$
 255 IF B$="N" THEN GOTO 20
 260 IF B$="Y" THEN GOTO 200
 265 IF B$="5" AND K<=22719 THEN
 LET K=K+1
 270 IF B$="8" AND K>=22529 THEN
 LET K=K-1
 275 GOTO 210
 399 REM *** VOICEPRINT FILE ***
 400 CLS
 405 PRINT AT 10,1;"ENTER STRING
TO BE RECOGNIZED"
 410 INPUT Z$
 415 PRINT AT 12,1;"ENTER FILE P
OSITION"
 420 INPUT R
 425 LET T$(R)=Z$
 430 PRINT AT 14,1;"PRESS ENTER
TO BEGIN"
 435 INPUT F$
 440 CLS
 445 FOR I=0 TO 7
 450 RAND USR 16520
 455 POKE 25997,I
 460 RAND USR 16615
 465 PRINT AT 10,16;I+1
 470 SLOW
 475 PAUSE 30
 480 FAST
 485 NEXT I
 490 POKE 25996,R
 495 RAND USR 16641
 500 PRINT AT 12,13;"AGAIN? (Y/N
)"
 505 INPUT B$
 510 IF B$="Y" THEN GOTO 400
 515 IF B$="N" THEN GOTO 20
 520 GOTO 505
```

```
599 REM *** RECOGNITION ***
600 RAND USR 16520
605 RAND USR 16707
610 CLS
615 PRINT AT 12,10;T$(PEEK 2599
9+1)
620 SLOW
625 PAUSE 60
630 FAST
635 IF INKEY$<>"" THEN GOTO 20
640 GOTO 600
799 REM  *** CLEAR FILES ***
800 FOR I=1 TO 10
805 LET T$(I)=""
810 NEXT I
815 FOR I=26000 TO 26640
820 POKE I,0
825 NEXT I
830 GOTO 20
999 REM ** DISPLAY STRING FILE
1000 CLS
1005 FOR I=1 TO 10
1010 PRINT AT (5+I),10;I;". ";T$
(I)
1015 NEXT I
1020 PRINT ,,,,"     PRESS ANY KE
Y TO CONTINUE"
1025 SLOW
1030 IF INKEY$="" THEN GOTO 1030
1035 FAST
1040 GOTO 20
1200 STOP
```

Table 3. Machine code and addresses.

16520	33	16582	205	16645	168	16708	144
16521	0	16583	207	16646	97	16709	101
16522	88	16584	64	16647	205	16710	1
16523	6	16585	35	16648	38	16711	255
16524	255	16586	12	16649	65	16712	0
16525	54	16587	29	16650	123	16713	197
16526	0	16588	32	16651	2	16714	17
16527	5	16589	248	16652	3	16715	0
16528	35	16590	201	16653	62	16716	88
16529	194	16591	126	16654	104	16717	14
16530	141	16592	167	16655	185	16718	0
16531	64	16593	200	16656	32	16719	6
16532	6	16594	254	16657	245	16720	64
16533	255	16595	43	16658	58	16721	26
16534	33	16596	56	16659	140	16722	150
16535	0	16597	2	16660	101	16723	48
16536	88	16598	62	16661	1	16724	2
16537	14	16599	43	16662	64	16725	47
16538	254	16600	71	16663	0	16726	60
16539	237	16601	197	16664	33	16727	129
16540	120	16602	213	16665	80	16728	48
16541	242	16603	229	16666	101	16729	2
16542	155	16604	205	16667	9	16730	62
16543	64	16605	178	16668	61	16731	255
16544	44	16606	11	16669	32	16732	79
16545	237	16607	225	16670	252	16733	35
16546	120	16608	209	16671	17	16734	19
16547	250	16609	193	16672	40	16735	5
16548	160	16610	5	16673	100	16736	32
16549	64	16611	194	16674	235	16737	239
16550	52	16612	217	16675	237	16738	121
16551	5	16613	64	16676	176	16739	193
16552	200	16614	201	16677	201	16740	185
16553	237	16615	6	16678	197	16741	50
16554	120	16616	64	16679	62	16742	216
16555	250	16617	33	16680	8	16743	89
16556	169	16618	160	16681	1	16744	48
16557	64	16619	97	16682	0	16745	5
16558	46	16620	58	16683	0	16746	79
16559	0	16621	141	16684	17	16747	120
16560	17	16622	101	16685	0	16748	50
16561	220	16623	133	16686	0	16749	143
16562	255	16624	111	16687	78	16750	101
16563	27	16625	17	16688	235	16751	4
16564	122	16626	0	16689	9	16752	62
16565	179	16627	88	16690	235	16753	10
16566	200	16628	213	16691	61	16754	184
16567	237	16629	17	16692	35	16755	32
16568	120	16630	8	16693	32	16756	212
16569	242	16631	0	16694	248	16757	201
16570	179	16632	25	16695	6	16758	33
16571	64	16633	209	16696	3	16759	136
16572	195	16634	26	16697	151	16760	64
16573	160	16635	119	16698	203	16761	151
16574	64	16636	19	16699	26	16762	6
16575	33	16637	5	16700	203	16763	238
16576	0	16638	32	16701	27	16764	134
16577	88	16639	244	16702	5	16765	35
16578	14	16640	201	16703	32	16766	5
16579	0	16641	1	16704	248	16767	32
16580	30	16642	40	16705	193	16768	251
16581	64	16643	100	16706	201	16769	79
		16644	33	16707	33	16770	201

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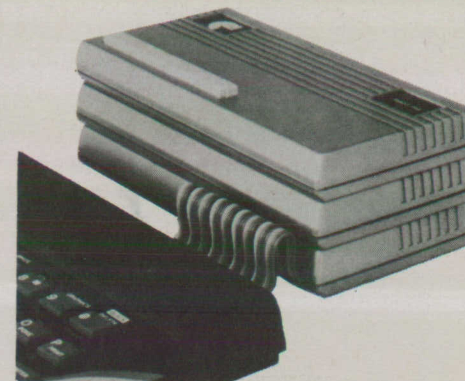

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MINIMAP — A mapping device which can expand address space to as much as 1 megabyte. When used with RAM 64 (from 1 to 16 RAM 64s) space is organized into vertical 64K pages. These pages are divided into SEGMENTS labeled: ROM, TOOL, FILE A, DATA, PATH, SLOT, FILE B.

Address	Segment	Size	Use
0000	ROM	(8K)	Computer BASIC interpreter and operating system.
2000	TOOL	(8K)	Machine coded routines or data storage.
4000	FILE A	(16K)	Normal residence of BASIC programs.
8000	DATA	(8K)	Used for extra data space or storing long BASIC programs.
A001	PATH	(4K)	Not presently used.
B000	SLOT	(4K)	Used in conjunction with other peripherals.
C000	FILE B	(16K)	Used for dislay but can be ued for BASIC if no display is used.

It is possible to have many BASIC programs, and several TOOL and DATA SEGMENTS, distributed among different PAGEs. The SEGMENTS may be "slid" relative to one another so that BASIC programs can use TOOL and DATA from a different page or so many BASIC programs can be simultaneously resident in different PAGEs.

EXAMPLES

ROM	ROM
TOOL 1	TOOL 3
FILE A3	FILE A2
DATA 1	DATA 3
PATH	PATH
SLOT	SLOT
FILE B3	FILE B2

It is possible to instantly switch between these different programs. The output of one program can also be used as the input of another program. RAM 08 and DROM can be used in TOOL and DATA positions and TOOLKIT in a TOOL SEGMENT. If you have a RAM 16 it could be used for FILE A while RAM 64 could fill four pages of FILE A or B.

RAM 16 — Sits on top of PERSONA to add 16K of RAM.............**$49.95**

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64K	$149.95	$145.95	*Includes interface and cable - shipping $10.00*		
Memopak Hi Res Graphics	$ 99.95	$ 96.95	GP250X Printer Package	$449.00	$438.00
Memopak Assembler	$ 49.95	$ 46.95	*Includes interface and cable - shipping $10.00*		
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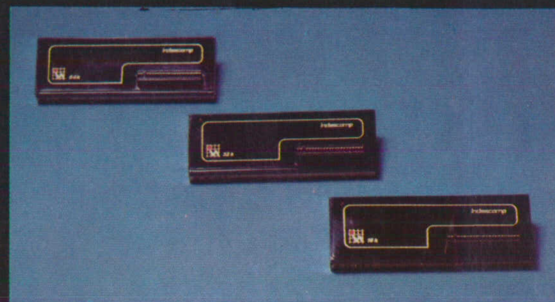

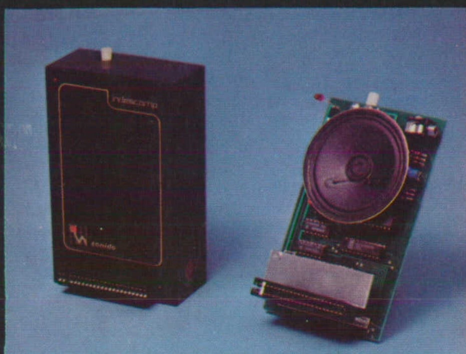

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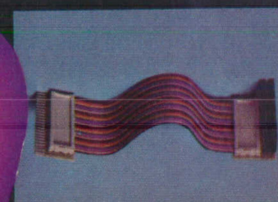

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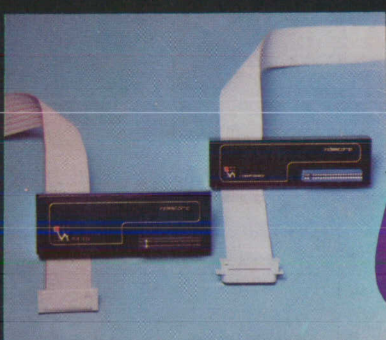

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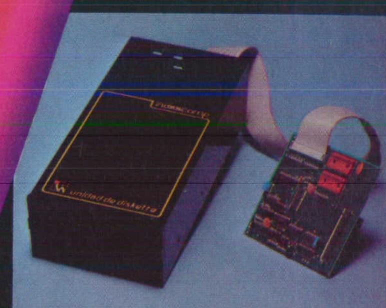

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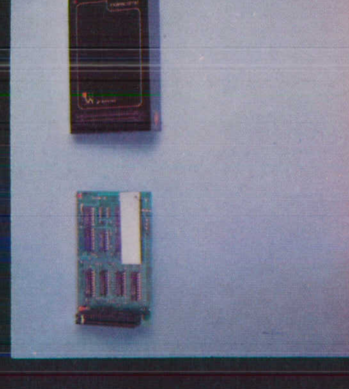

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Listing 2. Machine code loader.

```
 5 FAST
10 LET K=16520
15 PRINT AT 10,10;K
20 INPUT I
25 POKE K,I
30 LET K=K+1
35 GOTO 15
```

Listing 3. Basic routine for MC dump.

```
50 LET K=16520
55 CLS
60 FOR I=0 TO 19
65 PRINT PEEK (I+K),PEEK (I+K+
20)
70 NEXT I
75 INPUT J
80 LET K=K+40
85 GOTO 55
```

Speech Recognition Program

Listing 1 provides the speech recognition Basic program. Line 1 is a REM statement which contains the machine code routines. Once entered, Line 1 must never be edited. Doing so may unintentionally alter the machine code routines. Enter the program as follows. Remember, SAVE frequently.

1) Type a REM statement containing 270 spaces. Although this statement does not have to be numbered Line 1, it must be the first statement in the program.

2) Enter Listing 2.

3) RUN this program. From Table 3 INPUT the appropriate decimal entry for the displayed address. For example, the entry for 16520 is 33, for 16566 is 200. After typing each entry, press ENTER. Continue until all entries have been made. To exit the program, input a non-numeric character (such as W). The program will abort, giving an error code.

4) Check your work by typing the following line (without a line number)

```
PRINT USR 16758
```

Press ENTER. If the result displayed is 64, skip step 5 and proceed with step 6.

5) If you did not get 64 in step 4, you must find the error in the machine code. Listing 3 gives a Basic routine which dumps forty sequential bytes of memory in decimal format, starting with the byte at address 16520. The data is displayed in two columns reading down without the addresses. The second column starts at an address which is 20 locations higher than the beginning of the first. The next 40 bytes can be examined by inputting any number and pressing ENTER. You must keep track of the number of screens which have been displayed (the first screen starts at 16520, the second at 16560, the third at 16600, etc.). When an error is found, determine the address of the error and abort the program by entering a non-numeric character. Then POKE the correct value into this location. Repeat step 4.

6) With the machine code implanted in the first REM statement, enter lines 5 through 1200 of Listing 1. This will overwrite Listing 2 which is not needed any more.

7) SAVE *at least* one copy on tape.

8) The program can now be RUN.

Program Operation

Before RUNning the program, connect the amplifier board to the ear input of the computer. Remove the plug from the ear jack of the tape recorder and place it into the amplifier board jack. For convenience, you may also want to disconnect the mic cable from the recorder. The amplifier power switch can now be turned on.

RUN the program. The screen should appear as shown below:

```
            MENU
1. VOICEPRINT DISPLAY
2. VOICEPRINT FILE
3. RECOGNITION
4. CLEAR FILES
5. DISPLAY STRING FILE
6. STOP
       INPUT SELECTION
```

Any selection can be made at any time by entering only the corresponding command number. However, we will discuss the commands in the numbered order.

Voiceprint Display

Option 1 provides a pseudo frequency spectrum of any vocalized word or sound. After selection, a machine code routine is entered which monitors the ear input. Since this routine is designed to wait indefinitely for an input signal (a sound), the time between command selection and the actual signal input is not critical.

The routine samples the input 255 times or until a pause (silence) of at least 0.75 seconds is detected. The acquired data is then manipulated to form the histogram.

The histogram consists of 255 individual frequency channels, although only 64 can be displayed at one time. The left and right arrow keys (5 and 8, respectively, without shifting) permit other channels to be observed by shifting the display. The histogram is plotted highest to lowest frequency going from left to right. The y axis is the number of occurrences of a particular frequency (or channel). In this manner, a voice print is created. Data similar to that displayed in the histogram makes the rest of the program work. Typical voice prints for the

Figure 3. Histogram of "six".

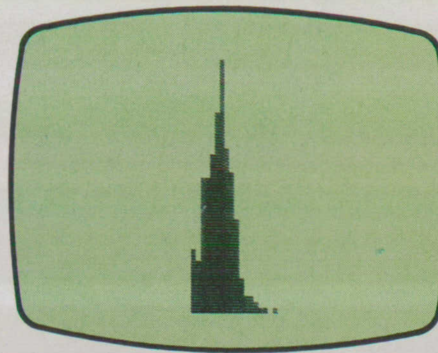


Figure 4. Histogram of "four".

words "six" and "four" are illustrated in Figures 3 and 4. Major differences in the voice prints of the two words are readily apparent. Due to the limited amount of data which is acquired, the system is best suited to single syllable words.

After making sure the amplifier board is connected and turned on, bring the microphone approximately two to three inches away from your mouth. Type 1 for the command selection and press ENTER. The screen should go blank. Now say a word naturally, but firmly. The screen should immediately appear with a voice print histogram and the query "AGAIN? (Y/N)". If nothing appears, gently tap the microphone. An almost blank histogram should appear. If still no response, remove the plug from the amplifier board and insert it into the cassette player ear jack. Then play a previously recorded tape (program, music, voice, etc.) at maximum volume setting. If a histogram does not appear, the amplifier board has a problem. Recheck your work; look for solder bridges and "cold" solder joints.

In response to "AGAIN? (Y/N)" enter Y to input and display another voice print or N to return to the main menu. Try different words and sounds. Pure tones, such as a crisp whistle, produce sharp histograms. Noisy phonemes, e.g., the "f" in four, produce a broader frequency spectrum.

After experimenting a while, you may have noticed the lack of data in the lower frequency channels. In fact, it is rare to find data below the 64th channel (where the 1st channel represents the highest frequency). This is due to the filtering characteristics of the computer's ear input circuitry. Essentially, the circuit performs as a high pass filter which significantly attenuates low frequency signals (below approximately 300 Hz). It is not surprising then that the lower range of the histogram appears blank. We employ this knowledge further by using only the first 64 channels for voiceprint file creation and recognition. This significantly saves both processing time and memory.

Voiceprint File.

Option 2 asks you to type in the word (up to 10 letters long) that you wish to have recognized.

Then a file position is requested for storing the string. There are ten file positions, each one corresponding to a word (or sound). Any string and voice print file entry may be replaced at any time, with no effect on the others.

After you enter a file position (1 through 10), the program waits for you to situate the microphone comfortably, preferably so that you can see the screen. Pressing ENTER continues the program.

When the screen goes blank, pronounce the word which was input as a string. The screen displays a 1 and goes blank. Say the word again. The screen responds with a 2, and goes blank. Continue this repetition of the word for a total of eight times. Do not begin pronouncing the word until the screen goes blank. After the eighth entry, "AGAIN? (Y/N)" will appear. Entering Y permits you to create another string and voiceprint file entry, N returns you to the main menu.

The reason for repetition is to create an "average" voice print for a particular word (or sound). You are actually "teaching" the computer to recognize a word or phrase. This significantly enhances the recognition ability of the system, but it also makes the recognition dependent upon the speaker and, as I somewhat embarrassingly discovered, room acoustics. So do not attempt to demonstrate the system to your users group (which may meet in a large classroom) with a set of voice prints you made in your paneled and carpeted den. Rather, make a set of voice prints in the location where the demonstration is to be made.

Recognition

Immediately after you input 3 for the recognition command, the program waits for voice input. This is indicated by a blank screen. Upon sensing an input, voice prints are compared and the string corresponding to the "best" matching voice print is displayed. This display appears for a period of time determined by the PAUSE statement in line 625. After this PAUSE another voice (sound) input is awaited.

To exit the recognition routine, press any key (except BREAK). The program will return to the main menu.

Clear Files

Option 4 clears all entries in both the voice print and string files.

Display String File

Option 5 displays the string file. This provides assistance in locating particular file entries before replacement or reentry.

Stop

Option 6 is self explanatory.

General Comments

As to be expected, the more dissimilar sounding the words to be recognized, the more accurate the system is in selecting the correct word. In other words, homonyms are out. This is a problem for a language such as Basic where the commands "for" and "four" and "to" and "two" are frequently encountered. Context becomes important in these cases.

The DIM statement in line 10 serves no other purpose other than moving E-LINE beyond the area where voice print files are created and stored. This permits a SAVE command to save existing voice print files on tape. To SAVE the voice print files, change line 10 to:

```
10 DIM C(1412)
```

then RUN the program. Voice print files will now be SAVEd with the program. After LOADing a program which contains voice prints, start with a GOTO 20 command. The RUN command will first clear the variable area, which includes the voice prints.

A Few Last Words

After experimenting for a while, you may wonder how the program works. A complete assembly listing along with a detailed explanation of each machine code routine and a commercially reproduced tape of the speech recognition program are available from G. Russell Electronics.

I hope this article will stimulate you into making the simple amplifier and trying the program. A project like this can open your eyes as well as your computer's ears.

G. Russell Electronics, RD 1, Box 539, Center Hall, PA 16828, (814) 364-1325, has available the documentation and program cassette for $9.95; the amplifier kit with the documentation and program cassette for $29.95; the amplifier assembled with the documentation and program cassette for $34.95; the bare silk screened circuit board for $4.95. All orders postpaid; MC/Visa accepted.

Speech Synthesizers *Paul Donnelly*

Your ZX/TS computer can talk to you, with the help of a "Speech Synthesizer" system. Speech or voice synthesis systems are combinations of hardware and software which, when tied in with your computer, can put electronically generated sounds and noises together into intelligible words and phrases. There are currently at least 16 semiconductor houses producing special LSI (Large Scale Integration) chips which can talk (see the March 1983 *Electronic Products*).

A synthesized voice can warn of problems, give a friendly response to a learner, open the world to the handicapped.

Voice Synthesis Techniques

These chips can all be computer controlled, and most use one of five principal synthesis techniques: Linear Predictive Coding, Allophone Synthesis, Pulse Code Modulation (PCM), Time Domain Synthesis, and PARCOR. The first two methods are the most popular and perhaps the easiest to obtain for your ZX/TS machine and will be the focus of this article.

Early attempts at recreating speech centered around digitally encoding actual spoken words. The problem with such methods was that prodigious amounts of memory (as much as 1M bit/word) were required for a microprocessor to speak in real time.

The PCM technique digitizes and compresses speech to the point where perhaps only 20 to 70 thousand bits are required for one second of speech. This is still a rather large requirement for a microcomputer. In addition, the entire vocabulary, just as it will be spoken, must be stored in memory (usually ROM) somewhere.

Paul Donnelly, 10 Idle Day Dr., Centerport, NY 11721

LPC uses an electronic model of the human vocal tract to produce sounds. In LPC, just as with PCM, the words we want the computer to say must be stored in ROM. In LPC, however, instead of a compressed duplicate of actual human speech being stored in ROM, only the parameters for producing the sounds are kept.

These parameters tell the "electronic mouth" when to perform the electronic analogue of exhaling fully, vibrating vocal cords, placing the tip of its tongue against the back of its teeth, etc. Straight LPC requires that the desired word be spoken by a human, into a special computer controlled filtering system and then stored in a ROM. Memory requirements are less than PCM, but so is speech quality. Straight LPC for your ZX/TS is perhaps best illustrated by the TI Speak and Spell interface article in *Computers and Electronics*, February 1983. TI's TMS 5220 chip works well with Z80 processors and can be used, for example, with their VM 71003 ROM chip to create a "talking clock" (see *Radio-Electronics,* May and July 1983).

"Phoneme" or "Allophone" synthesizers start with as few as 64 basic sounds (the phonemes) or their variants (the allophones) which can be used to make up most of the words of a spoken language. These use a number of techniques, including LPC, to concatenate these fundamental sounds into words. In this case, there is virtually no off chip ROM requirement, as simple 8 bit codes representing the phonemes can be stored in the RAM of your computer and fed through the synthesizer one at a time. Speech quality is often not as high as ROM word based LPC or PCM, due to the limited number of phonemes or ways of combining them. The General Instrument/Voicetech units mentioned in *Radio-Electronics*, March 1983, and used in the R.I.S.T. Parrot, and Votrax's SC-01 chips are of the LPC allophone type. G.I. also makes ROM-based LPC chips (SPO 250) (see *Radio-Electronics,* June 1983, on talking computer games).

Synthesizer Chips

The synthesizer chips themselves have been dropping in price faster than the TS1000 in recent months, with chips which used to sell for up to $100 now going to OEM's for less than $10 and in some cases less than $5.

Complete synthesizer units consisting of the synthesizer itself, operating system, and ROM (if required) can now be purchased for from $30 (Cheaptalk) to $100 (Digitalker). Most of these can be easily interfaced with a ZX/TS through a Z80 PIO or other peripheral interface.

Uses of Speech Synthesis

What can you use speech synthesis for? In a security system, a synthesized voice can warn you of impending problems verbally. Other annunciator uses include overtemperature, hi-water level, "lights on," etc. All of these can warn you of situations requiring your attention. In education uses, a voiced response can be more "friendly" for young or novice students. Speech or visually handicapped people can even use their ZX/TS to communicate with the world. How about adding some interesting byplay to your favorite game, or make the "voice" your third eye when running complicated action/adventure games. The voice can describe your general circumstances, while you concentrate on the visual information presented on the immediate screen.

The Best Technique

"Which is the best technique for long term?" has been a big question in the field of voice synthesis for a long time. Generally, as we said, the more memory intensive systems sound better, but cost more, and are relatively inflexible. The allophone systems are cheaper and more versatile, but produce speech that is far from human sounding. The dividing line between the ROM-based and allophone systems seems to be blurring as hardware manufacturers strive to get the best of both worlds. As an example, consider that prefixes (e.g., the AT in ATTACK) of many words in some ROM-based systems can be addressed individually. We might be getting very close to using phonemes with such slicing. Similarly, with certain pairs of English letters, there is no specific combination of two individual letter sounds which produces the correct sound for both if they appear in a particular word (this is called coarticulation). The only way to get really accurate reproduction of these sounds is to add them to our basic list of allophones in ROM.

A judicious blend of hardware, software (e.g., in a small on-board ROM), and expandability should provide a system capable of realistic, infinitely variable speech. This is, we understand, the sort of approach which Votrax, one of the leaders in the field, is following with its second-generation systems.

One final note, while adequate hardware and quite a few word libraries exist today, there is very little adequate software for users and even OEM's. The development of user friendly, comprehensive software packages for the various personal microcomputers will greatly enhance the usefulness of your "talking" computer.

"Gee, Dad, I was playing my new video game... 'War'... and I lost!"

The ZON X-81 Sound Generator

Sharon Zardetto Aker

ZON X-81 Programmable Sound Generator. Bi-Pak, PO Box 6, Ware, Herts, U.K. $49.95 plus shipping.

The Bi-Pak ZON promises a "huge range of possible sounds." It certainly has great potential, but that potential is not so easily realized.

A Hardware Standpoint

The ZON is a small unit (2" x 3" x 5 15/16") with a built in speaker, a manual volume control, and an expansion port in its back. It plugs into the expansion port of your ZX/TS computer. However, four hardware questions need to be raised.

1) The slot guide notch in the rear port was so narrow that my RAM pack slot pin remained stuck in the ZON. A small knife easily widens the notch, but it should have been sized properly to begin with.

2) With the TS2040 printer in the line-up, the overheating was so severe that program crash occurred, sometimes after only a few minutes of use.

3) The ZON's printed circuit board, a glass expoxy board with excellent etching and plating, is only 1/32" thick. This is flimsy enough to be susceptible to damage from something as simple as a hurried insertion into the computer.

4) The circuit designers, evidently unaware of the Sinclair decoding scheme for the I/O ports, unnecessarily tied up all but one of the computer's eight ports. The documentation warns that the use of the ZON with any other I/O mapped device is not guaranteed.

The saving grace, technically speaking, is that the sound chip is state of the art.

Sharon Zardetto Aker, 20 Courtland Dr., Sussex, NJ 07461.

A User's Viewpoint

While the documentation gives a lot of information, it is lacking in quantity and clarity. For example, in one place "period" refers to the duration of a sound while later it used interchangeably with "pitch." A formula is given for generating a tone based on its frequency, but only the frequency for middle C is supplied.

The sample programs for sounds such as a gunshot, a laser, a whistle, and bells give a better idea of the programming methods than the instructions. One excellent short program lets you load the registers repeatedly to experiment to develop a particular sound.

Thirteen registers control pitch, envelope, tone or noise, and channel volume. Loading these registers is cumbersome, as a loading routine has to be executed for each register and every change. Although this is usually possible at an acceptable speed, entering the program is tedious. Each register and its contents must be identified by LET statements with a GOSUB for every load.

A machine code loading routine is stored in an initial REM statement. A nine line, six variable Basic routine to POKE values into some of the REM reserved addresses is recommended as the first nine lines of any program. However, except for the initial REM, the Basic routine is easily pared down to a four line, three variable subroutine that can be placed at any convenient program line.

The one major drawback of the ZON is that some sound effects are possible only in FAST mode. This may require sacrificing your display. The sounds that do not work in SLOW are mostly explosions and tones which should change rapidly and smoothly in pitch, e.g., the whistle of a falling bomb.

The ZON also lacks an envelope to give a single rise to maximum with a drop back to zero. This is just what you need for a dragon roar. Using the next best envelope gives about the same sound as the dragon in the Atari 2600 "Adventure" cartridge: good, but not great.

The limitations of the ZON will probably be considered in the same way that ZX/TS limitations are: a challenge to be cleverly programmed around. It is likely that the ZON will be forgiven its technical shortcomings, tedious programming, and confusing documentation the first time you turn your keyboard into an organ or hear the aliens fly across your screen.

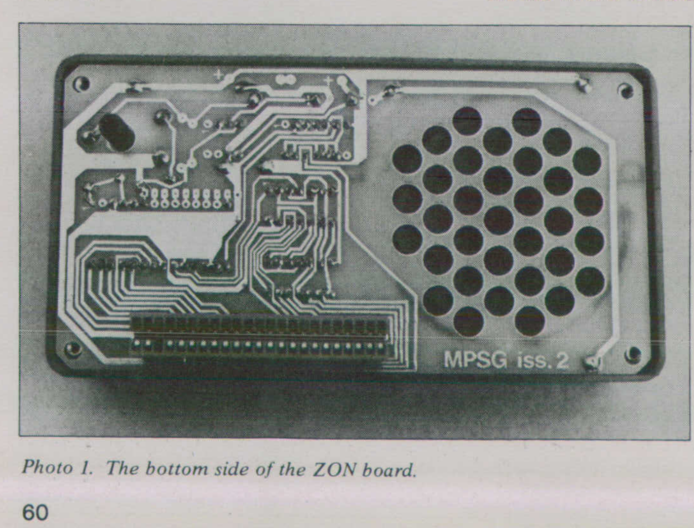


Photo 1. The bottom side of the ZON board.

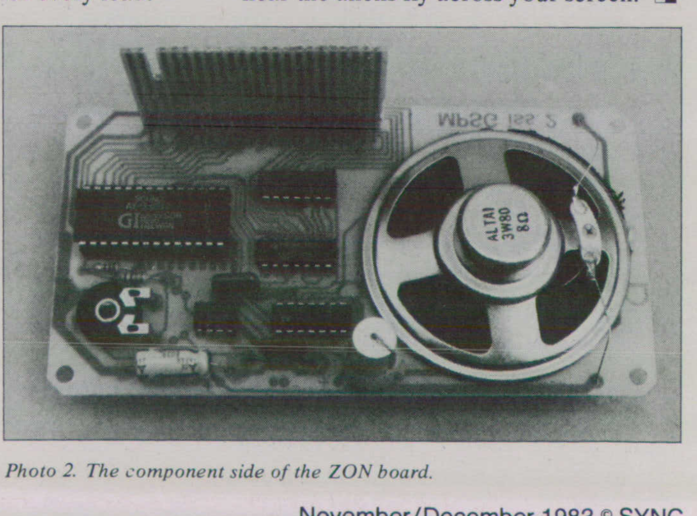


Photo 2. The component side of the ZON board.

"Hello, Z80 Calling..." *Harry Doakes*

8K ROM; 1K RAM

In the last installment of this series on Z80 machine code programming, we translated a program that took more than 200 bytes of machine code. It was so big that it could not quite fit into a computer with less than 2K RAM.

This time, we will look at "ROM calls," the machine code subroutines stored in the ROM of your computer. They can help keep your Z80 programs shorter, and save programming time and effort.

But before we use ROM subroutines, let's take a look at machine code subroutines in general, and, to understand *them*, we will first look at a feature the Z80 microprocessor has that Basic does not share—the *stack*.

Stacked

Let's start with an example in Basic. Suppose you say

```
LET X=5
```

Then the variable X will have a value of 5. You could also say

```
LET X=5
LET X=62
LET X=297
LET X=5
```

but when you are finished with this string of LET statements, X will once again equal 5, not 62 or 297. Every time you LET X equal a new number, it completely forgets everything else it ever knew.

But two special types of machine code instructions for the Z80 microprocessor can help solve that forgetfulness problem. They are the PUSH and POP instructions, and they have to do with the *stack*.

The stack is like a list—a list of numbers, stored somewhere in memory. The instruction PUSH adds another number to the list. POP, on the other hand, retrieves the last number that was added, and crosses it off the list.

Suppose you want to save the number

Harry Doakes, PO Box 10860, Chicago, IL 60610.

ROM calls, the machine code subroutines stored in your ROM, make your programs shorter and save time.

that is in the HL register pair, but you do not want to put the number into a variable. You can use the instruction

```
PUSH HL
```

and the number is added to the list. It is safe until you

```
POP HL
```

when it drops off the list and back into the HL register pair.

In the meantime, you can also PUSH and POP other numbers. They will all be safe on the list—in exactly the same order that you pushed them. For example, if you

```
PUSH HL
PUSH DE
PUSH BC
```

all three numbers go on the list, in order. You can then use those registers for something else, if you like, until it is time to get the numbers back again. Then you just reverse the process:

```
POP BC
POP DE
POP HL
```

and the original numbers you PUSHed are back again, safe and sound.

Safety First

What good is all this PUSHing and POPping? Well, remember that there are only a handful of registers in the Z80 processor. Sometimes you need to save a number, but it is just not convenient to make a machine code variable. The stack is a quick and convenient way of saving that number.

There is a disadvantage, though: you must remember *what order* you put numbers on the stack. If you forget, and POP the numbers in a different order than you PUSHed them, you will end up with numbers in the wrong registers.

For example, with

```
PUSH DE
PUSH HL
POP DE
POP HL
```

the number that started in register pair DE ends up in HL, and what started in HL ends in DE.

Of course, any disadvantage can be an advantage, too. If you PUSH and then POP numbers in the "wrong" order, you have an easy way to switch numbers between register pairs.

Mechanics Illustrated

How does it work? It is really pretty simple.

The Z80 processor has a special double-sized register, the *stack pointer*, called register SP for short. Remember how a register can be used as a pointer? It is like PEEK in Basic: the register *points to* a specific location in memory. For example, if register pair HL contains the number 75, then

```
LD A,(HL)
```

will get whatever number is in memory location 75, and put it in register A. In Basic, you could say

```
LET A=PEEK(HL)
```

It also works the other way:

```
LD (HL),A
```

is very much like Basic's

```
POKE HL,A
```

Now remember: the stack is a list, and register SP always points to the last number you added to the list.

The program counter keeps track of where the computer is in your machine code program and always points to the beginning of the next instruction.

When you PUSH a register pair, e.g., register pair BC, this is what happens:

First, the stack pointer, register SP, is decremented, that is, it is reduced by 1.

Then the number in register B is POKEd into the memory location that SP points to.

Then register SP is decremented again, and this time it is register C that is copied into the location SP points to. (Remember, registers B and C *do not change* while all this is happening; only the memory locations that SP points to will change.)

Figure 1 shows what the process would look like if you had to do it step-by-step—first in Basic, then in Z80 machine code instructions:

Figure 1.

Basic	Machine code
LET SP=SP-1	DEC SP
POKE SP,B	LD (SP),B
LET SP=SP-1	DEC SP
POKE SP,C	LD (SP),C

As you have probably guessed, POP is exactly the reverse of PUSH. Figure 2 shows how POP BC would look, step by step:

Figure 2.

Basic	Machine code
LET C=PEEK(SP)	LD C,(SP)
LET SP=SP+1	INC SP
LET B=PEEK(SP)	LD B,(SP)
LET SP=SP+1	INC SP

You cannot add a number in the middle of this list of numbers, but only at the bottom. Nor can you "cross out" a number if it is in the middle of the list. Whether you are adding or removing a number, you always have to work from the bottom.

Handle with Care

The stack is a great place to keep things safe, but do not get *too* enthusiastic about PUSHing things onto it. Here is why: the more times you PUSH without POPping, the longer your list will get. Register SP will point to lower and lower memory locations, and eventually, if you are not careful, it will point to other important things in memory, such as a machine code program, Basic variables, or the display file, and wipe them out.

To avoid that problem, the ZX80, ZX81, and TS 1000 all start the stack pointer off just about as high as possible. That means the stack starts out very near the top of your RAM memory, so there is usually lots of room for the list to get longer.

That brings up something else to beware of: be careful not to POKE holes in the list. Suppose you POKE a number into a memory location that is part of the stack. What happens? Well, you will change the value that was already there. Then, somewhere along the line, a number will POP, but it will not be the value that was originally PUSHed. That can mean problems.

Always be careful about POKEing around in high memory locations. Remember, the stack is a safe place as long as you help keep it safe.

You can use the PUSH and POP instructions with any of the three register pairs—BC, DE, and HL. You can also PUSH and POP register pair AF. That is register A, along with the flags (the zero flag, the carry flag, and all the others) that are sent up or down at the end of each instruction. (None of the stack instructions affect any of the flags.)

Pathfinder

Another register, called the *program counter* (register PC for short), can be PUSHed on the stack. Like register SP, it is a special double-sized register that can hold any number from 0 to 65535. Like SP, register PC always points to a memory location. The program counter keeps track of where in your machine code program the computer is.

For example, when you first turn your computer on, the program counter is 0, and that is where the Z80 processor goes to look for its first instruction, memory location 0. After getting the instruction that is stored in memory, the first thing the Z80 does is add 1 (or 2 or 3 or 4, depending on how many bytes long the instruction is) to the number in register PC. That way, PC always points to the beginning of the next instruction.

For example, after

```
LD A,B
```

it adds 1 to the number in PC because that instruction takes up just one memory location. In the case of

```
LD HL,6723
```

the program counter would go up by three since this instruction takes three bytes of memory.

Maybe you remember when we first encountered relative jumps—the instructions that make the processor jump forward or backward only a certain number of bytes. When the program says

JR 6

it really means "add 6 to register PC" and

JR -12

means "subtract 12 from register PC." (Think about that a moment. It is tricky, but it makes sense.)

Of course, a regular jump, such as

JP 17430

just loads the number 17430 into register PC. Then the program counter points to location 17430, and that is where the Z80 processor looks to get its next instruction.

Obviously, this makes PC an important register. If it accidentally gets fouled up, there is no telling where the processor might go looking for instructions. Fortunately, it is pretty difficult to make that kind of mistake with Z80 instructions, except for *one* way, which we will see as we look next at machine code subroutines and how they work.

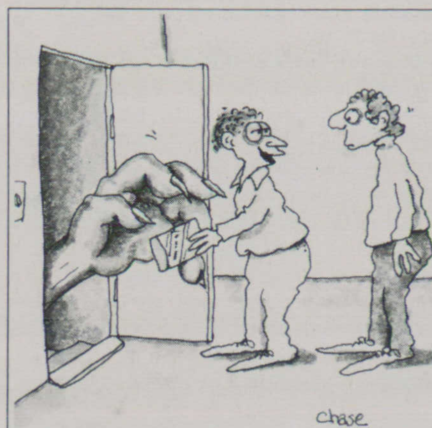
CALLing All Subroutines...

Chances are, after you read through your manual the first time, you understood how a subroutine works. It is a sort of miniature program inside your program. When your Basic program hits the command

GOSUB 1000

it skips to line 1000, and begins working there. It follows through until it hits the command RETURN. Then it jumps back to the program line *immediately following the GOSUB command* and continues from there.

GOSUB is a Basic command for Basic subroutines. To use a machine code subroutine from your machine code program, you need the Z80 instruction CALL. Like the machine code "jump" instruction, JP, it tells the processor to go to a memory location (there are no line numbers in a Z80 program). But just as GOSUB is a little different from GOTO in Basic, CALL and JP work in slightly different ways.



"Oh, he's perfectly happy down there... As long as I give him a new video game every so often!"

Let's take a look, step by step, at what happens when the Z80 meets an instruction such as

CALL 16984

First, the processor adds 3 to the program counter, register PC (CALL is a three-byte instruction). As a result, PC points to the first instruction following the CALL instruction.

Then, *before* it jumps to the subroutine, it PUSHes PC onto the stack.

Finally, it makes the jump by sticking the number 16984 into register PC. Now the program counter points to memory location 16984, and that is where the Z80 goes looking for its next instruction.

In other words, CALL is just like JP *except* that, after a CALL instruction, something has been added to the stack.

Maybe you have already guessed what the machine code return instruction RET does. It POPs a number off the stack and into register PC. If everything has worked right, that number makes the PC point to the instruction immediately following the CALL instruction, and the Z80 continues from there.

Make sure you have the same number of POP instructions as PUSH instructions in any MC subroutine.

Think about that a minute. It is important. Suppose things have *not* gone right, say, something else has been PUSHed on the stack. Then RET will POP the wrong number into the program counter, and the Z80 will go looking in the wrong place for its next instruction.

Or suppose the original number has been POPped off the stack already. Once again, the Z80 will get lost, and chances are the computer will lock up or destroy your program. If that happens, you have to unplug it and start all over again. When register PC gets fouled up, all sorts of things can go wrong.

It is worth repeating: be careful when you use the stack. Always make sure that, if you PUSH something, it eventually gets POPped. Make sure you have the same number of POP instructions as PUSH instructions in any machine code subroutine. That way, you will never lose your place in the stack, and your machine code program will stay on track.

One last note on using CALL instructions: the numeric version (the one the computer understands) is always three bytes. First is 205 (CDh); then comes the memory location where the subroutine begins, a number from 0 to 65535. As usual, you should divide it by 256, and make the remainder the second byte of your CALL instruction, and the quotient the third byte.

The Mysterious "ROM Calls"

One of the advantages to using machine code on a TS/ZX computer is that you do not always have to do everything yourself. That is because the Basic language interpreter program (the one that is stored in ROM) has to do a lot of very common things that other machine code programs also have to do such as get information from the keyboard and print things on the screen. It usually uses subroutines to do these things.

Some of the ROM subroutines can get rather complicated to use. The routines that handle floating-point arithmetic in the 8K ROM, e.g., require all sorts of special preparation. But others are relatively simple, and the best way to get a good feel for how to use subroutines is to try a few of them out.

A word of warning: all of the subroutines I will refer to in this section are in the 8K ROM, and the information applies *only to* this ROM. If you have a 4K ROM, or any other ROM, this information probably will not be much help. Sometimes there are "monitor listings" available for different ROMs; from these you may be able to figure out where useful machine code subroutines appear in the ROM, and how to make use of them. But there is no standard place to put the "print a character" routine, e.g., so, for now at least, I will just cover it for the 8K ROM.

One other reminder:all ROM routines use some of the Z80 registers. If you have a number in, say, register pair BC that you do not want to lose, be sure either to save the number in a machine code variable, or PUSH BC onto the stack before you CALL the subroutine (and, of course, POP BC after the subroutine is finished). Otherwise the subroutine may use register pair BC, and you may lose your number.

Figure 3.

```
PRINT: LD A,54    ;"Q" in register A
       CALL 16    ;print it
```

"Billy! It's one of your computer friends at the door!"

Figure 4.

```
INPUT: CALL 699       ;scan the keyboard
       LD A,253       ;if H>253, scan again
       CP H
       JR C,INPUT
       LD B,H         ;put HL in BC
       LD C,L
       CALL 1981      ;find the character
       LD A,(HL)      ;put the character in A
```

Figure 5.

```
INKEY$: CALL 699      ;scan the keyboard
        LD A,253      ;if H>253, skip it
        CP H
        LD A,255      ;if no key, A=255
        JR C,NEXT
        LD B,H        ;put HL in BC
        LD C,L
        CALL 1981     ;find the character
        LD A,(HL)     ;now the character's in A
  NEXT: (whatever comes next)
```

Figure 6.

```
  PLOT: LD B,Y          ;Y is the vertical
        LD C,X          ;X is the horizontal
        LD A,128        ;to PLOT
        LD (16432),A
        CALL 2994       ;plot it

UNPLOT: LD B,Y          ;Y is the vertical
        LD C,X          ;X is the horizontal
        LD A,0          ;to UNPLOT
        LD (16432),A
        CALL 2994       ;unplot it
```

Get a free Z80 reference guide from Zilog, listing all the Z80 instructions, what they do, and the hex numbers.

PRINT

The first routine is the "print a character" routine, located at memory location 16 (0010h). To use it, you put the number of the character you would like to print in register A, then call the subroutine.

For example, the letter "Q" is character number 54. Figure 3 shows how to print it on the screen.

This works just like the PRINT function in Basic, except that it prints just one character at a time. You can use it for any character in the regular or reversed character set, i.e., character numbers 0 through 63 and 128 through 191. You can also use it with character number 118, the ENTER character that starts a new line on the screen.

INPUT

The INPUT routine is a little more complicated. The computer uses two different ROM calls to find out what key on the keyboard is being pressed.

First, the routine at 699 (02BBh) scans the keyboard. When it is done, there is a pair of numbers in registers H and L indicating what key has been pressed. If register H is 255 (FFh), no key has been pressed; if it is 254 (FEh), only the SHIFT key was pressed. Anything else means that a regular key was pressed.

Next, if there is a regular key pressed, the number in HL has to be put into register pair BC. Finally, the routine at 1981 (07BDh) goes to work; when it is done, register pair HL points to the correct character.

The description may make it sound difficult, but Figure 4 shows the routine. It is easy to use, and works like the INPUT function in Basic: it waits until you press a key before continuing with the program. However, it only checks the keyboard for one key.

INKEY$

Figure 5 shows how to modify the INPUT routine slightly so it works like the INKEY$ in Basic.

This time, if no key (or just the "shift" key) has been pressed, register A contains 255; otherwise it contains the character code for the key pressed.

Be careful using the INPUT (or INKEY$) and PRINT routines together. Some of the character codes you can get from the keyboard, such as LPRINT (code 225) or THEN (code 222), cannot be printed by the PRINT routine. It only works with individual characters or their inverses (code numbers 0-63 and 128-191) and the ENTER code, 118.

SCROLL

This one is fast and easy to use. It works just as in Basic. When you use the subroutine at 3086 (0C0Eh), the display moves up a line, and the cursor drops to the bottom line of the display.

SCROLL: CALL 3086

FAST and SLOW

I mentioned before that there is no standard place to put machine code routines in ROM. That is why the routines are in different places in the 4K and 8K ROMs.

In fact, there are two different versions of the 8K ROM itself. That means you will have to do a little bit of testing to make sure of which version you have. In SLOW mode, type in

LET A=USR 3872

One of two things should happen: either your screen shows "0/0" in the lower left-hand corner and you are in FAST mode now, or it shows "8/0" and you are still in SLOW mode.

If it shows "0/0", use these ROM calls:

FAST: CALL 3872
SLOW: CALL 3880

If it shows "8/0", you should use these:

FAST: CALL 3875
SLOW: CALL 3883

PLOT and UNPLOT

For each of these commands, you will need a horizontal coordinate between 0 and 63, and a vertical coordinate between 0 and 43. That's right. It is just like PLOT and UNPLOT in Basic. The horizontal X-coordinate goes in register C, with the vertical Y-coordinate in register B. Both PLOT and UNPLOT use the ROM subroutine at 2994 (0BB2h); the only difference is that PLOT POKEs the number 128 into memory location 16432 (4030h) before calling the ROM subroutine, while UNPLOT POKEs the number 0 into that location. Figure 6 shows the routines.

Figure 7 is a program in both Basic and machine code that uses both ROM calls and the PUSH and POP instructions. First type in the program in Basic, RUN it in SLOW mode, and use the arrow keys to draw lines on the screen. (To use the arrow keys, hold down the SHIFT key while you press 5, 6, 7, or 8.) Then use the loader program in Figure 8 to put in the machine code version and see how much smoother and faster the program becomes.

Letters, We Get Letters...

Wanda Dietrich, of Blanca, Colorado, writes to suggest, "Please, at the end of each article list all the instructions and what they stand for. Not what they mean—you have already explained that—just what they stand for in English." The list of instructions keeps getting longer, but Figure 9 should help.

You can get a free Z80 reference guide from Zilog, the company that designed the Z80 microprocessor, listing *all* the Z80 instructions and what they do, including the numerical codes (in hexadecimal) and more technical information than you are ever likely to need. To get a copy, write to Zilog, Inc., 1315 Dell Avenue, Campbell, CA 95008. Be sure to mark your letter "Attn: Tech Publications," and ask for the Z80 CPU Programmer's Reference Guide.

Next time, we will take a look at how to use that free reference guide. We will also look at a wide-ranging collection of Z80 instructions that can work on numbers just one *bit* at a time. They are not used as often as LOAD or JUMP instructions, but they can still come in handy for all kinds of programs.

If you have comments or questions about machine code programming, or something is not quite clear, let me hear from you. Be sure to send along a stamped, self-addressed envelope if you need a reply.

Figure 8. Program using both ROM calls and PUSH and POP.

First, reserve 83 bytes of space at the top of memory:

```
  10 PRINT "HOW MANY BYTES?"
  20 INPUT A
  30 LET RT=PEEK 16388+256*PEEK
16389
  40 LET RT=RT-A
  50 LET H=INT (RT/256)
  60 LET L=RT-256*H
  70 POKE 16388,L
  80 POKE 16389,H
  90 NEW
```

Now type in this program (the REM line contains the hex digits of the program in Figure 7):

```
   1 REM 0E200616C53E80323040CDB
20BCDBB023EFDBC3EFF3806444DCDBD0
77EC1FE7020083E2BB828010418DAFE7
120083E00B828010518CEFE7220083E0
0B928010D18C2FE7320083E3FB928010
C18B6FE0020B2C9
  10 LET RSTART=16514
  20 LET START=PEEK 16388+256*PE
EK 16389
  30 LET A=0
  40 LET H=PEEK (RSTART+2*A)-28
  50 IF H<0 OR H>15 THEN GOTO 12
0
  60 LET L=PEEK (RSTART+2*A+1)-2
8
  70 IF L<0 OR L>15 THEN GOTO 12
0
  80 LET N=16*H+L
  90 POKE START+A,N
 100 LET A=A+1
 110 GOTO 40
 120 LET H=USR START
```

Figure 7.

```
Hex codes             Instructions         Basic version
0E 20                 LD C,32              10 LET X=32
06 16                 LD B,22              12 LET Y=22
C5             PLOT:  PUSH BC              20 PLOT X,Y
3E 80                 LD A,128
32 30 40              LD (16432),A
CD B2 0B              CALL 2994
CD BB 02   INKEY$:    CALL 699             30 LET A$=INKEY$
3E FD                 LD A,253             32 IF A$="" THEN GOTO 30
BC                    CP H
3E FF                 LD A,255
38 06                 JR C,UP
44                    LD B,H
4D                    LD C,L
CD BD 07              CALL 1981
7E                    LD A,(HL)
C1               UP:  POP BC
FE 70                 CP 112               40 IF A$<>CHR$ 112 THEN GOTO 50
20 08                 JR NZ,DOWN
3E 2B                 LD A,43              42 IF Y<>43 THEN LET Y=Y+1
B8                    CP B
28 01                 JR Z,+1
04                    INC B
18 DA                 JR PLOT              44 GOTO 20
FE 71           DOWN: CP 113               50 IF A$<>CHR$ 113 THEN GOTO 60
20 08                 JR NZ,LEFT
3E 00                 LD A,0               52 IF Y<>0 THEN LET Y=Y-1
B8                    CP B
28 01                 JR Z,+1
05                    DEC B
18 CE                 JR PLOT              54 GOTO 20
FE 72           LEFT: CP 114               60 IF A$<>CHR$ 114 THEN GOTO 70
20 08                 JR NZ,RIGHT
3E 00                 LD A,0               62 IF X<>0 THEN LET X=X-1
B9                    CP C
28 01                 JR Z,+1
0D                    DEC C
18 C2                 JR PLOT              64 GOTO 20
FE 73          RIGHT: CP 115               70 IF A$<>CHR$ 115 THEN GOTO 30
20 08                 JR NZ,BREAK
3E 3F                 LD A,63              72 IF X<>63 THEN LET X=X+1
B9                    CP C
28 01                 JR Z,+1
0C                    INC C
18 B6                 JR PLOT              74 GOTO 20
FE 00          BREAK: CP 0
20 B2                 JR NZ,PLOT
C9                    RET
```

Figure 9. Instructions and meanings.

Instruction	Name	Example	Basic equivalent
ADD	add	ADD A,C	LET A=A+C
CALL	call	CALL 16	GOSUB 16
CP	compare	CP 5	* if A=5, set zero flag; if A<5, set carry flag
DEC	decrement	DEC DE	LET DE=DE-1
INC	increment	INC C	LET C=C+1
JP	jump	JP 18514	GOTO 18514
JR	jump relative	JR -3	* go back 3 bytes
LD	load	LD B,17	LET B=17
NEG	negate A	NEG	LET A=-A
POP	pop	POP HL	* retrieve a number from the stack and put it in HL
PUSH	push	PUSH BC	* save the number in BC on the stack
RET	return	RET	RETURN
SLA	shift left	SLA D	LET D=D*2
SRA and SRL	shift right	SRA E	LET E=INT (E/2)
SUB	subtract	SUB A,H	LET A=A-H

If a CALL, JP, or JR instruction is followed by C or Z, it means:

C: Do this only if the carry flag is up.

Z: Do this only if the zero flag is up.

Parentheses around a number or register name indicate a pointer:

LD A,(17396) means LET A=PEEK (17396)

LD (HL),B means POKE HL,B

The Linear Search

Thomas B. Woods

Do you want to store and retrieve information with your computer? This program uses a machine language search routine that is so fast you can blitz through a full 13000 bytes of files to find the one you want in less than a second!

The program uses Basic to create files and PRINT found ones. It is only the search which runs in assembly language. So even if you find Z80 source code a complete mystery, you can program "around" the machine language search to create your own data management program with super fast access to any file stored in memory.

The Concept

Linear data storage is a simple and straightforward method of holding information in your computer. Simply stated, a large block of memory is set aside for files. Data that you want to input is placed in that memory block one character at a time, one after another. When you need access to a particular file, you input a search word which can be found in the file you want. Then you scan the block of files until you find a match to the word you input. When a match is found, you PRINT the file.

The program creates a very large REM line for the data storage block; 13000 spaces to be exact. Data held in REM has the advantage of being saveable on your tape recorder. It is unaffected by CLEAR or RUN, and its position in memory is fixed. The block of data always begins at the same memory address. This makes programming a bit easier than when data is held in a string. Information to be stored in the Data REM Line is POKEd into it just

Thomas B. Woods, PO Box 64, Jefferson, NH 03583.

The program creates a very large REM line for data, 13,000 spaces to be exact.

Figure 1. Data REM builder.

```
 1 REM 12E▙RNDLN ▣▄TAN
 2 LET D=PEEK 16396+256*PEEK 16397-2
 3 FOR I=1 TO 13ØØØ
 4 POKE 16515,INT ((D+I)/256)
 5 POKE 16514,D+I-256*PEEK 16515
 6 RAND USR 16516
 7 POKE D+I,Ø
 8 NEXT I
 9 POKE D-1,INT ((13000+2)/256)
1Ø POKE D-2,13ØØØ+2-256*PEEK (D-1)
11 REM
```

After the word REM in line 1, enter the following characters:

```
the number 1
the number 2
the letter E
graphic shifted W
the token  RND
the token  LN
inverse period
graphic shifted D
the token  TAN
```

There are no spaces in line 1.

Figure 2. Machine Code loader.

```
   1 REM (32 spaces)                   -Type REM, then 32 spaces, then ENTER
   5 REM (65 spaces)                   -Line 1 holds the search command
   6 REM (29 spaces)                   -Line 5 holds the assembly routine
1ØØØ FOR X=165Ø7 TO 17ØØØ              -Line 6 is not used. DO NOT LEAVE OUT.
1ØØ5 PRINT AT Ø,Ø;"HIT ENTER  TO       -2 spaces between ENTER and TO
 GOTO NEXT ADDRESS ""P"" TO POKE
 THIS ADDRESS";TAB Ø;"""S"" TO S
TOP",,"""G"" TO GOTO A NEW ADDRE
SS";TAB Ø;"""B"" TO BACK UP"
1Ø1Ø PRINT AT 7,Ø;"ADDR  PEEK CH
R$ "
1Ø15 PRINT AT 8,Ø;X;" ";PEEK X;"
   ";TAB 12;CHR$ PEEK X;"     "        -Type 5 spaces between the quotes
1Ø2Ø INPUT X$
1Ø25 IF X$="S" THEN STOP
1Ø3Ø IF X$="P" THEN GOTO 2ØØØ
1Ø35 IF X$="B" THEN LET X=X-2
1Ø4Ø IF X$="G" THEN GOTO 15ØØ
1Ø5Ø NEXT X
1Ø6Ø STOP
15ØØ PRINT AT 1Ø,Ø;"INPUT STARTI
NG ADDRESS"
151Ø INPUT X
152Ø PRINT AT 1Ø,Ø;"
                                "      -That's 32 spaces
153Ø GOTO 1Ø1Ø
2ØØØ PRINT AT 1Ø,Ø;"INPUT A DECI
MAL VALUE"
2Ø1Ø INPUT Y
2Ø2Ø POKE X,Y
2Ø3Ø GOTO 152Ø
```

Figure 3. System variables and key MC addresses.

Address Decimal	Hex	Name	Function
16507	407B	FILE PEEK (2 bytes)	-The last two bytes of the Sinclair system variables area of memory. these bytes are not used by the BASIC so you can use them for whatever you want. FILE PEEK points to the starting address of found files for display.
16514	4082	SEARCH COMMAND WORD (32 Bytes)	-The first byte after 1 REM. This is where you store the search command word.
16552	40A8	MC SEARCH (65 Bytes)	-The first byte after 5 REM. This is the start of the assembly routine that does the byte blitzing.
16583	40C7	LASTCHR	-Starting address of MC SEARCH which handles found files.
16604	40DC	D Ptr (2 bytes)	-This address resides in 5 REM. A 2 byte pointer which shows MC SEARCH where to begin looking.
16606	40DE	BC Ctr (2 Bytes)	-Also located in 5 REM. Counts how many bytes have been searched.
16608	40E0	NOGOT	-Starting address of MC SEARCH which handles unlisted search commands.
16623	40F0	not used	-The first byte after 6 REM. These 29 bytes are not used by the program but you must not leave them out. They might someday be useful for another assembly language routine.
16658	4112	DATA BYTE	-First byte of Data Storage REM. (line 11)

Figure 4. Code for MC SEARCH.

For address:	Poke the value:	For address:	Poke the value:
16552	42	16586	43
16553	220	16587	126
16554	64	16588	254
16555	237	16589	23
16556	75	16590	202
16557	222	16591	212
16558	64	16592	64
16559	17	16593	195
16560	130	16594	202
16561	64	16595	64
16562	26	16596	34
16563	237	16597	123
16564	177	16598	64
16565	226	16599	237
16566	224	16600	67
16567	64	16601	222
16568	19	16602	64
16569	26	16603	201
16570	254	16604	0
16571	155	16605	0
16572	202	16606	0
16573	199	16607	0
16574	64	16608	33
16575	237	16609	18
16576	161	16610	65
16577	202	16611	1
16578	184	16612	1
16579	64	16613	0
16580	195	16614	195
16581	175	16615	212
16582	64	16616	64
16583	34		
16584	220		
16585	64		

like a machine code routine gets POKEd into REM.

When you want to access a file, you input a search command. This command can be any word, symbol, or phrase. Just as with the data files, the search command is POKEd into its own special REM line. The search routine then compares the characters of the search REM with the characters of the data REM until a match is found.

Entering the Program

Entering the program is a three step process.

Step 1

First, the large data REM is built. The program used to create this REM line was adapted from "Space in REM" by Frank O'Hara which appeared in the August issue of *SYNTAX*. After you enter and RUN the REM Builder listed in Figure 1, line 11 turns into a REM state-

dk'tronics

4K TOOLKIT

This is the toolkit which won acclaim in the feature in the August 1982 issue (pages 29 and 30) of Sinclair User. "It is the most impressive program, fast in execution with clear and full instructions...it stands out from the rest of the field." The ZXED is a powerful editor for use on the expanded ZX81. It is intended for use by the serious BASIC programmer and offers several useful and time saving features most helpful during all stages of program development. The facilities provided are as follows: ALTER, BYTES, COPY, DELETE, FIND, HELP, INSERT, KEEP, MOVE, RENUMBER AND VERIFY.

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Figure 5. Basic Listing.

```
                                           Notes
  12 LET P=Ø                               ; P indicates the no. of DATA BYTES
  14 CLS                                     poked.
  15 PRINT "        ZX FILE/FINDE          ; The search command input menu.
R           ",,"ENTER A SEARCH C
OMMAND OR TYPE  "A" TO ADD A NEW
 FILE             "
  2Ø INPUT X$
  21 IF X$="" THEN GOTO 2Ø
  3Ø IF X$="A" THEN GOTO 5ØØ               ; Type "A" to add a new file.
  35 LET X$=X$+"▣"                         ; Otherwise the word you input is
  5Ø FOR X=1 TO LEN X$                       poked into the first rem line.
  6Ø POKE 16513+X,CODE X$(X)
  7Ø NEXT X
  8Ø POKE 166Ø6,P-256*INT (P/256           ; Lines 80 and 90 poke the value of P
)                                            into BC Ctr. This variable tells the
  9Ø POKE 166Ø7,INT (P/256)                  computer how many bytes to check.
 1ØØ POKE 166Ø4,18                         ; Lines 100 and 110 load D Ptr with the
 11Ø POKE 16605,65                           address of the first byte of 11 rem.
 12Ø CLS
 122 LET B=USR 16552                       ; The machine language search.
 125 PRINT X$( TO LEN X$-1);TAB
Ø;"FILE/SEARCH",,,,
 13Ø LET X=PEEK 165Ø7+256*PEEK 1           ; The variable X takes on the value of
65Ø8                                         the address held in FILE PEEK.
 135 FOR Y=X TO X+P                        ; The loop then Prints the file begin-
 14Ø IF PEEK Y<>192 THEN PRINT C             ning at address X.
HR$ PEEK Y;
 15Ø IF PEEK (Y+1)=192 OR PEEK (           ; If a "*" or """" is encountered, the
Y+1)=23 THEN GOTO 2ØØ+(2Ø*(PEEK              program jumps to either 200 or 220.
(Y+1)=23))
 17Ø NEXT Y
 18Ø GOTO 22Ø
 2ØØ PRINT                                 ; A quote image will lower the printing
 21Ø NEXT Y                                  one line.
 22Ø PRINT AT 16,Ø;"HIT ENTER TO           ; An asterisk indicates the end of a file.
 CONTINUE SEARCHING "R" TO RETUR             You jump to the display option menu.
N TO PREVIOUS FILES "N" TO BEGIN
 A NEW FILE/SEARCH  "
 23Ø INPUT Y$
 235 IF Y$="R" THEN GOTO 80                ; Type "R" to start the same search over.
 24Ø IF B AND Y$="" THEN GOTO 12           ; Type ENTER to continue searching.
Ø
 245 IF Y$<>"N" THEN GOTO 22Ø              ; Type "N" to start a new search.
 25Ø GOTO 14
 5ØØ PRINT AT 7,5;"ADD/FILE"               ; ADDING new files begins here.
 51Ø FOR X=1 TO 4                          ; This loop lets you input 4 lines of
 52Ø PRINT AT 7,14;"INPUT LINE "             data.
;X
 53Ø INPUT X$
 54Ø IF X=1 THEN LET A$="*"+X$             ; The first line always starts with "*".
 55Ø IF X>1 THEN LET A$=A$+""""+           ; Lines 2 to 4 begin with a quote image.
X$
 56Ø PRINT AT 8+X,Ø;X$
 57Ø NEXT X
 58Ø PRINT AT 16,Ø;"HIT ENTER TO           ; After you input your new file, it gets
 LOG THIS LISTING OR""C"" TO COR             printed and this line lets you change
RECT IT";"                                   your mind about entering it into REM.
                        "                    (40 spaces between the quotes)
 585 INPUT X$
 59Ø CLS
 595 IF X$="C" THEN GOTO 5ØØ               ; Type "C" to go back to re-enter the file.
 6ØØ FOR X=1 TO LEN A$                       Otherwise, each character of the new
 61Ø POKE 16658+P,CODE A$(X)                 file is poked into the next free byte
 62Ø LET P=P+1                               of 11 REM. After each Poke, P is
 63Ø NEXT X                                  incremented.
 635 POKE 16658+P,23                       ; Then a "*" is planted at the end.
 66Ø GOTO 14                               ; When ADD/FILE is complete, the computer
                                             returns to the search command menu.
```

ment containing 13000 blank spaces. Imagine putting this line in manually!

The program takes about 7 minutes to run. When it finally does stop with a report 0/11, delete lines 1 through 10 by typing in the line number and ENTER. This will leave you with a single REM line—line 11—which consists of 13000 blank spaces.

Step 2

The second part of the program involves entering the search command REM, the search routine REM, and the loader program which lets you POKE in the machine code search routine. Add to line 11 the listing shown in Figure 2.

This program steps through each address of memory between 16507 and 17000. First the address is PRINTed, then the value stored in that byte. Finally the character the value represents is displayed. After display of each byte, the program gives you these options:

1) Hit ENTER if you want to continue to the next address.
2) Press "S" to STOP.

Figure 6. MC SEARCH Routine.

	Decimal Address	Decimal Code	Hex Address	Hex Code	Mnemonic	Notes
	16552	42	40A8	2A	LD HL,(NN)	load HL with value held in D Ptr
	16553	220	40A9	DC	40DC=D Ptr	
	16554	64	40AA	40		
	16555	237	40AB	ED	LD BC, (NN)	Load BC with BC Ctr contents
	16556	75	40AC	4B		
	16557	222	40AD	DE	40DE=BC Ctr	
	16558	64	40AE	40		
	16559	17	40AF	11	LD DE,NN	load DE with addr. of first byte
	16560	130	40B0	82	4082=com.	of command word
	16561	64	40B1	40		
	16562	26	40B2	1A	LD A, (DE)	put the character in Accumulator
	16563	237	40B3	ED	CPIR	compare value in A with the value
	16564	177	40B4	B1		at addr. specified by HL;inc HL; decr. BC; repeat.
	16565	226	40B5	E2	JP PO.NN	Is BC=0? Yes? Goto NOGOT
	16566	224	40B6	E0		
	16567	64	40B7	40	40E0=NOGOT	
	16568	19	40B8	13	INC DE	Does Chr match? Take next Chr.
	16569	26	40B9	1A	LD A, (DE)	and put it in Accumulator.
	16570	254	40BA	FE	CP N	-is it an inverse period?
	16571	155	40BB	9B	9B=inverse "."	
	16572	202	40BC	CA	JP Z, NN	Yes? Goto LASTCHR
	16573	199	40BD	C7	40C7=LASTCHR	
	16574	64	40BE	40		
	16575	237	40BF	ED	CPI	No? Compare it w/next search
	16576	161	40C0	A1		command chr; inc HL; dec BC.
	16577	202	40C1	CA	JP Z, NN	Match? Go back-check next chr.
	16578	184	40C2	B8	40B8	
	16579	64	40C3	40		
	16580	195	40C4	C3	JP NN	No match? Goto 40AF to check
	16581	175	40C5	AF	40AF	another first character.
	16582	64	40C6	40		
LASTCHR	16583	34	40C7	22	LD (NN), HL	put HL in D Ptr
	16584	220	40C8	DC	40DC=D Ptr	
	16585	64	40C9	40		
	16586	43	40CA	2B	DEC HL	Step back-put value located at
	16587	126	40CB	7E	LD A, (HL)	addr. specified by HL in Accum.
	16588	254	40CC	FE	CP N	is it a "*"?
	16589	23	40CD	17	17="*"	
	16590	202	40CE	CA	JP Z, NN	Yes? Goto 40D4
	16591	212	40CF	D4	40D4	
	16592	64	40D0	40		
	16593	195	40D1	C3	JP NN	No? Go back to 40CA to look more.
	16594	202	40D2	CA	40CA	
	16595	64	40D3	40		
	16596	34	40D4	22	LD (NN). HL	Put HL in FILEPEEK
	16597	123	40D5	7B	407B=FILEPEEK	
	16598	64	40D6	40		
	16599	237	40D7	ED	LD (NN), BC	Put BC in BC Ctr
	16600	67	40D8	43		
	16601	222	40D9	DE	40DE=BC Ctr	
	16602	64	40DA	40		
	16603	201	40DB	C9	RET	Return to BASIC
D Ptr	16604	0	40DC	0		Bytes 40DC and 40DD are D Ptr
	16605	0	40DD	0		
BC Ctr	16606	0	40DE	0		Bytes 40DE and 40DF are BC Ctr
	16607	0	40DF	0		
NOGOT	16608	33	40E0	21	LD HL, NN	Put Address of 1st DATA BYTE in HL
	16609	18	40E1	12	4112=DATA BYTE	
	16610	65	40E2	41		
	16611	1	40E3	1	LD BC, NN	Load BC with 1.
	16612	1	40E4	1	01	
	16613	0	40E5	0		
	16614	195	40E6	C3	JP NN	Goto 40D4
	16615	212	40E7	D4	40D4	
	16616	64	40E8	40		

3) Press "P" to POKE this address.
4) Press "B" to BACK UP one address
5) Press "G" to GOTO a different starting address.

Use the program to input the machine code search routine and to inspect important addresses to make sure everything is added properly.

The Linear Search routine uses several system variables the same way that the Sinclair Basic uses them. Figure 3 lists the addresses of these important bytes and describes their functions. Also listed are key addresses of the search routine.

Before you enter the MC SEARCH routine you should use the loader program (Figure 2) to make sure you entered the REM lines correctly. Check the program against these values. At each of the following addresses you should find the PEEK value of 118;

16546; The last byte of 1 REM
16617; The last byte of 5 REM
16652; The last byte of 6 REM

When you are sure everything is right, begin entering the MC SEARCH. Since the routine begins at 16552, type "G" and input this address when prompted. Begin POKEing the code from the table in Figure 4. Remember to push "P" for every byte you wish to POKE.

POKEing in the code from Figure 4 fills the 65 space REM line (line 5) with the MC SEARCH instructions.

Step 3

When you are done, you are ready to enter the third and final phase of the program: Typing in the Basic. This part executes file inputs to the Data REM and displays found files.

There is no need to delete the loader program. When you are experimenting with the search routine, you can use the loader to PEEK into the various pointers as well as observe the search command and data REMs.

Figure 5 lists the Basic routines. Simply insert the lines into what you already have typed into your computer.

How The Program Works

When you RUN the program, the first line to be executed is

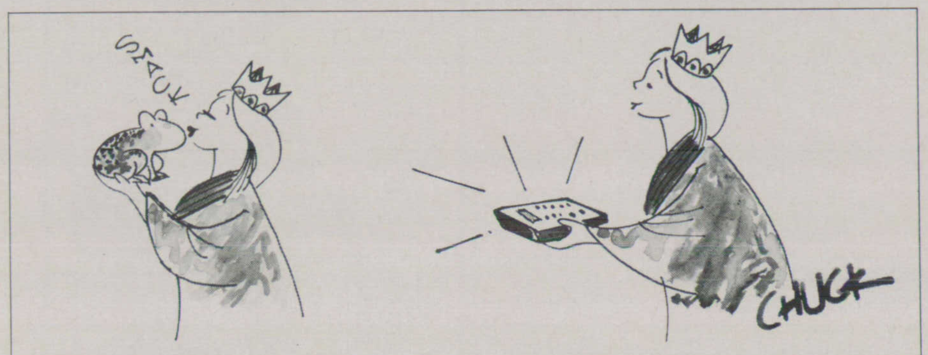
12 LET P=0

This variable represents the number of data characters used in the data REM line. Since you have not added any files yet, P is initialized with the value of zero.

Line 15 prints the search command menu. From here you can either input a command word or let the computer know that you want to ADD a new file. If you type "A", line 30 sends you off to the ADD/FILE routine beginning at line 500.

ADD/FILE uses a FOR-NEXT loop to let you input four lines of data. For each value of the loop, you input a line of information at line 530.

This program "marks" each line you input with two very important symbols. These file markers are used by both the machine code search and the Basic display routines. Every file begins with a "*" and each new line of data begins with a quote image. Lines 535 and 540 insert these symbols into the string of data you input. For each iteration of the loop, these lines put the text you input into one long string (A$). If you are inputting the first line, A$ becomes "*"+X$ (the line you input). If you are adding lines 2 through 4, line 540 adds a quote image, then the line of text.



Line 545 displays your new file. After all four lines are put into A$, lines 580 to 595 are executed. The prompt tells you that if you see a mistake in the new file, you can correct it by pressing the letter "C".

Press any other key and the file gets added to the data REM line. This is done in lines 600 to 635. The FOR-NEXT loop takes each character of A$ and POKEs it into the next unused byte of the data REM. After each POKE, the variable P is incremented by line 620.

Before ADD/FILE is complete, line 635 POKEs a file marker (*) into the space immediately following the last character of the newly added file. This marker tells the computer to stop PRINTing when it is displaying files.

The line says

POKE 16658+P,23.

23 is the code number for an asterisk. See the ZX81 owners manual for a complete list of all characters and their codes. The file is added. We now jump back to line 14; the search command menu.

Before you actually add your first file, you should note how the machine code search works. If the search routine cannot find a file which contains the search word you input, the computer PRINTs the first file of the data REM line. Therefore, your first file should be an informative statement like "SEARCH IS COMPLETE". Even though the program asks for four lines of data per file, it is perfectly legal to input a one liner. To add empty line, just hit ENTER when lines 520 and 530 ask you to INPUT a line of text.

Finding and PRINTing Files

The linear search hunts for any word, symbol, or phrase you want. Every file which contains the words or characters in question get PRINTed. This "seek and print" routine begins at line 15, the search command menu. This is where we ADDed new files by typing "A". If you do not type "A", the computer tacks an inverse period onto the end of the word you INPUT when line 35 is executed. This symbol indicates to the computer that it is the last character of the search command word.

Next, lines 50 to 70 POKE the search command into the first REM line of the program.

Before the MC SEARCH is called, lines 80 to 110 initialize both BC Ctr and D Ptr to their proper values. At the beginning of every search, BC Ctr takes the value of P. D Ptr receives the address of DATA BYTE, the first character of the data REM line (address 16658). When BC Ctr and D Ptr have these values, the MC SEARCH knows it must begin searching at the beginning of the data REM line and continue searching until it has gone through every used byte of stored data.

The hunt for the first file which contains the search command word is ready to commence. Line

122 LET B=USR 16552

breaks the computer from Basic and executes the assembly language instructions beginning at address 16552. This line does more that just jump to the USR code. It also sets up the variable B. The value that B assumes is the number which is held in the BC register pair on return to Basic . In the assembly language routine, the BC pair acts as a counter of each byte of data searched. BC starts off equal as a counter of each byte of data searched. BC starts off

equal to P and decrements with each byte until it reaches zero. The variable B, then, does the same thing. When B=0, the computer knows that the search is complete.

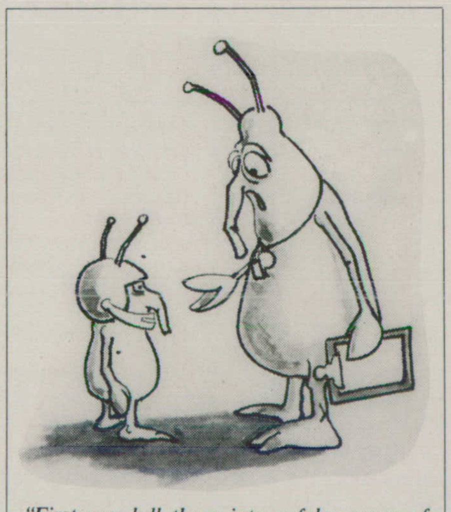
Figure 6 shows exactly what the MC SEARCH does.

Essentially, the Machine Code Search takes the first character of the search command word and checks it against every character held in the data storage REM. When it finds a match, the routine compares the next character of the search word with the next character of the data REM. With every match the operation repeats until the computer reaches the last character of the search word (an inverse period) or until it finds 2 non-matching characters. If the last character of the search word is encountered, the computer steps back through the REM until it finds a file marker (*). This indicates the beginning of a found file. The variable FILEPEEK is loaded with the address the marker is occupying, D Ptr marks the spot where the file was found, and BC Ctr is loaded with the number of data bytes still unchecked. Completing this, the computer returns to Basic.

If the search resulted in a non-match, the computer simply resumes searching for a match of the first character of the search word until the entire block of occupied loads FILEPEEK with the address of the first file in the data REM. Then it returns to Basic.

File Display

With FILEPEEK loaded and the computer back in Basic, line 130 takes FILEPEEK's address and assigns it to the variable X. Then lines 135 to 210 display the file. At 135, a "Y" loop is initialized. Its first value is X or the address held in FILEPEEK. The next line checks each byte of data held in address



"First you lull them into a false sense of confidence with a couple of perfect runs..."

The SEARCH command checks the first letter of the word against each letter in REM until it finds a match; then it repeats with the second letter, and so on.

Y to see if it is a quote image (CHR$ 192). If it is not, the character held in that address gets PRINTed.

Line 150 checks the next byte for a quote image or an asterisk. If the computer finds one of these file markers, the command:

GOTO 200+(20*(PEEK (Y+1)=23))

is executed. The expression

(PEEK (Y+1)=23

is actually a number.

If PEEK (Y+1) really does equal 23, the number is 1.

If PEEK (Y+1) does not equal 23, the number is 0.

So depending on the PEEK value of address (Y+1), the computer will

GOTO 200+(20*1) or 220

if it finds an asterisk (PEEK Y+1=23), or

GOTO 200+(20*0) or 200

if it finds a quote image.

If the quote image is encountered, lines 200 to 210 simply move the PRINTing down one line. Then the computer jumps right back into the loop to PRINT more characters.

But, if the asterisk is found, we have come to the end of the file, or more precisely, the beginning of the next file: GOTO 220.

Here, we find a list of display options. After the text of the menu is PRINTed, line 230 lets you make your selection.

If you type "R" meaning RETURN to previous file displays, line 235 sends you back to line 80. This has the effect of making the same search over again. This is useful when you have several files that contain the same search word. If, after printing the third or fourth file, you want to go back to look at the first one, type "R" to RETURN.

Line 240 says that, if B is not equal to zero (the search has not yet progressed through all occupied bytes of the data REM) and you press just ENTER, then GOTO 120. This jumps you back into the MC SEARCH. D Ptr and BC Ctr remember where the computer stopped before it printed the last file, and searching resumes from that point. Hitting ENTER, therefore, lets you continue the search through the remainder of the Data REM.

Finally, if you type "N", line 245 sends you back to line 14. This breaks the search entirely and you can INPUT a new search command word.

Conclusion

This program showed you one way to store information, find it with lightning speed, and display that information once it is found. A good data base must also take into consideration many other design parameters. How do you edit existing files? How do you delete those that are out of date? What other display options need to be included? What about SAVEing the program on tape? How can files longer than four lines be stored?

Every new capability added to a program uses valuable memory space which could otherwise be used for data storage. Finding ways to combine the most function with the most data capacity is perhaps the greatest challenge of all.

Directory of User Groups

Joining a user group is one of the best ways of learning about your computer and sharing what you have learned.

The following Directory of User Groups ranges from groups that have been established for some time (shown by club name) to groups just getting underway (usually indicated by "area:"). Some groups are special interest groups (SIG) within larger computer clubs. Many groups have chosen a name which can be used to make an acronym.

The groups fall into three categories: Groups in the US; Groups outside the US; Topical Groups.

The states and countries are given in alphabetical order. Within the states the groups are arranged in ZIP order.

The name and address of the contact person follows the club name or area. The telephone numbers given are usually for the contact person and calling times are indicated as: (d): day; (e): evening; (h): home; (w) work. NL following the contact indicates that the group publishes a newsletter with the name in italics. The area served by a group is given next if the area is not clear from the group name.

In most cases the groups have modest dues which usually include the cost of the newsletter if any.

If you want to contact a group in your area, either call the number listed or write a letter to the address. All the groups will appreciate the courtesy of a self-addressed, stamped envelope (the long size) since they do not have secretaries or unlimited budgets for postage. In general an SASE will get you a quicker reply.

Groups in the US

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Bob Boyer
1103 Rivlin Rd.
Huntsville, AL
(205) 883-4354 (e)

Arizona
1st Sinclair Users Group of Phoenix
Randy Saxton
4827 N. 63rd Dr.
Phoenix, AZ 85033
(602) 846-2882

Timex/Sinclair Users Group
PO Box 41795
Tucson, AZ 85717

California
West Los Angeles ZX80/81 Users Group
PO Box 34545
Los Angeles, CA 90034
Attn: Dr. George Kuby
(213) 550-5035
(afternoons only)

South Bay Computer Club
c/o John W. Petersen
2316 Walnut Ave.
Manhattan Beach, CA 90266
(213) 545-9581

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Robert Jorgenson
3814 Coleman Ave.
San Diego, CA 92154
(619) 424-6202
NL. San Diego County area.

Carpenteria area:
Harvey Wheeler
Box 704
Carpenteria, CA 93013

Monterey Timex/Sinclair Computer Club
John S. Taylor
698 Van Buren
Monterey, CA 93940

Peninsula T/S User Group
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NL: *Timelinez*
San Francisco-San Mateo area.

Timex Sinclair Users Nationally Active Megagroup, Inc.
c/o Walt Gaby
3325 Pierce St.
San Francisco, CA 94123

Association of Greater Bay Area Timex User Groups
Paul Perreault, Organizer
947 Clara Dr.
Palo Alto, CA 94303
NL: *Timelinez*

South Bay Timex/Sinclair Users Group
Paul D. Perreault, Dir.
947 Clara Dr.
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Richmond, CA 94805
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High Score Video Arcade
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2301 Mission St.
Santa Cruz, CA 95060

Sacramento Timex/Sinclair Users Group
Jim Hirleman, Chair
3655 Sunset Blvd., No. 42
Rocklin, CA 95677
(916) 624-9103

Colorado
Mile High Chapter T/S Users
Peter J. Callinicos, Pres.
12026 W. Virginia Pl.
Lakewood, CO 80228
(303) 986-4843. NL.

Connecticut
Sinclair/Timex Users Group
c/o Carol Doyle
1070 S. Colony Rd.
Wallingford, CT 06492
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Chris Baldwin
Sinclair Study Group
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Fairfield County User Group
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Ridgefield, CT 06877
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Orlando Area Sinclair Users Group
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Kennedy Space Center, FL 32815

ZX80 Southeast Region Club
Ralph Coletti, Pres.
869 Levitt Parkway
Rockledge, Fl 32955
NL

South Florida Timex/Sinclair Users Group
Bob Pearsall
9220 Fountain Rd.
Lake Worth, FL 33463

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PO Box 5021
Spring Hill, FL 33526
(904) 683-3961

Timex and Sinclair Bay Area Microcomputer Users Group
PO Box 644
Safety Harbor, FL 33572
NL: *Keyboards*

Cape Coral area:
Richard Perkins
157 S. W. 49th St.
Cape Coral, FL 33914
(813) 542-1640

Georgia

Timex User Group of Marietta, Georgia
Hubert Crowell
3105 Mary Dr., N.E.
Marietta, GA 30066
NL

Metro-Atlanta Area ZX Users
Jeff Feinsmith
1640 Bethaven Rd.
Riverdale, GA 30296
(404) 997-0204

Atlanta Sinclair/Timex Users Group
Phil Hoffstadter
PO Box 2842
Atlanta, GA 30301
(404) 529-4326

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Chicago/Des Plaines Area Sinclair Users Group
Circle Chess Computer Club
Attn: A. F. Stanonis
PO Box 63
Des Plaines, IL 60017
(SI: Circle Chess)

Sinclair Users Network
2170 Oak Brook Cir.
Palatine, IL 60067
(312) 934-9375. NL.

Evanston area:
Brendan P. Holly
1246 Elmwood Ave.
Evanston, IL 60204

Sinclair-Timex TS/ZX SIG
PO Box 25599
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Subsumed under CACHE, Chicago Area Computer Hobbyist Exchange. NL: *Sinclarion*.

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Anderson, IN 46011
(317) 644-1873 (h)
(317) 644-8861 (w)

Indiana Software Group
4620 Mission Ct. E.
Columbus, IN 47203
(812) 372-4042

Indiana/ S. Illinois/S.W. Ohio/ N.W. Kentucky area:
Send long SASE to:
The FUN-Z
PO Box 914
Jasper, IN 47546

Indiana Group
Camille Herbert, Dir.
PO Box 230
Goodland, IN 47948

Louisiana

Greater New Orleans area:
E. V. Sandy Blaize
417 Ridgewood Dr.
Metairie, LA 70001

Maryland

Baltimore ZX/Timex Group
Joe Brennskag
354 Langley Rd.
Baltimore, MD 21221
(301) 682-3096 (e)

Bowie Timex-Sinclair Computer Club
Lowell Denning
12611 Beechfern Ln.
Bowie, MD 20715
(301) 262-2821

Lanham Sinclair Users Group
Cora C. Dickson, Editor
9528 Elvis Ln.
Lanham, MD 20706
(301) 577-6645
NL: *The Computerist*

Prince George's Sinclair Users Group (PG-ZUG)
Jim Wallace
5442 Tilden Rd.
Bladensburg, MD 20710
(301) 699-8712

Westinghouse ZX80/1 Users Club
Jack Fogarty
Westinghouse MS 3525
PO Box 1521
Baltimore, MD 21203
NL

Massachusetts
Sue Mahoney, Dir.
Sinclair/Timex User Group
c/o The Boston Computer Society
Three Center Plaza
Boston, MA 02108
(203) 573-5816. NL.

Missouri
Computer Users Group Timex Sinclair 1000 & ZX80/81
Peter Wolcott
305 West 51 Terr.
Kansas City, MO 64112
(816) 753-8546. NL.

Joplin area:
Jim I. Brown
PO Box 2221
Joplin, MO 64803

Nebraska
Sinclair User Network
Patrick Murphy
4903 Walker
Lincoln, NE 68504
(402) 464-8086. Lincoln-Omaha area.

New Jersey
North Jersey Shore area:
Bill Thompson
PO Box 427
Rumson, NJ 07760

Morris County area:
Larry Spencer
6 Forest Ct.
Morris Plains, NJ 07950
(201) 285-7819 (d)
(201) 267-5566 (e)

Cumberland County Area Timex/Sinclair Users
Jerry Sweet
110 Nth St.
Millville, NJ 08332
(609) 825-7116

New Mexico
New Mexico Computer Society
4608 Hilton Ave., N.E.
Albuquerque, NM 87110
Or contact John Brown:
(505) 888-4661

New York
ZX Users Group of New York
PO Box 560 Wall St.
New York, NY 10005
USA and International users welcome.

Sinclair Users Group Newsletter
c/o George Repicky
49 Roosevelt Ave.
Schenectady, NY 12304

Mid-Hudson Users Group
Fr. Bruce O. Bowes
Church of the Resurrection
Hopewell Jct., NY 12533
(914) 226-5727

Sinclair Computer User's Society (SINCUS)
PO Box 36
Glen Aubrey, NY 13777
NL: *SINCUS.* Broome/Tioga, NY, and Susquehanna Co., PA.

Southern Tier area. Signup at:
Unicorn Electronics
Small Mall
Harry L. Drive
Johnson City, NY 13790

North Carolina
Triangle Sinclair Users Group
c/o Douglass Bewey
206 James St.
Carrboro, NC 27510
(919) 929-3079. NL.

Ohio
Delaware/Central Ohio area:
Hovey M. Cowles
315 S. Sandusky St.
Delaware, OH 43015
(614) 369-4281

Columbus area:
Gary Solomon
1653 Brice Rd.
Reynoldsburg, OH 43068
(614) 861-3600

Timex/Sinclair Users Group
R. F. Sieg
19502 Thornridge Ave.
Cleveland, OH 44135

Timex/Sinclair Users Group of Cincinnati
Rick Johnson
11 Funston Ln.
Cincinnati, OH 45218
(513) 825-1449

T/S Research
Steve Douglas
1515 Canfield Ave.
Dayton, OH 45406
Home and recreational uses.

S. Ohio/N. Kentucky area:
R. Arthur Gindin
1823 Kinneys Ln.
Portsmouth, OH 45662

Oklahoma
Sinclair Computer Users Group of Oklahoma
Sgt. Patrick Spera
Box T-148
Tinker AFB, OK 731145

Oregon
Portland Area Timex Sinclair Users' Group
Michael D. Veine
PO Box 3153
Portland, OR 97208

Portland area:
J. E. De Groot
2146 N.W. Johnson St., #108
Portland, OR 97210

Clackamus County ZX/TS Users
Bob Evans
2615 SE Courtney Rd., No. 19
Milwaukie, OR 97222
(503) 659-9207

Pennsylvania
Pittsburgh Area Computer Club (SIG: Sinclair)
Dick Welsh
1605 Middlecrest Dr.
Glenshaw, PA 15116
(412) 487-0789

Central Pennsylvania ZX/TS Users Group
Penn State Univ.
University Park
Bill Russell, Group Leader
RD 1, Box 539
Centre Hall, PA 16828
(814) 364-1325

Central Pennsylvania ZX Users Group
Jim Whittaker
Quarters G, Antrim Dr.
Mechanicsburg, PA 17055
(717) 766-8365

South Carolina
Allendale County Computer Users' Group
Gary West
PO Box 345
Allendale, SC 29810

Tennessee
Chattanooga Area Sinclair Users
Dan Williams
PO Box 1321
Collegedale, TN 37315

Memphis ZX81 Users Group
James Barker
3791 Barron Ave.
Memphis, TN 38111
(901) 327-2158

Texas
Educator's User Group
c/o M. Mark Wasicsko
Associate Dean
School of Education
Texas Wesleyan College
Ft. Worth, TX 76105
Free NL to educators

Houston (West) Timex/Sinclair Users Group
David C. Bonner
13327 Rain Lily Ln.
Houston, TX 77083
(713) 495-4403 (7-9 pm)

Utah
Utah Sinclair Users Group
Larry Scanlan
2718 E. 9725 South
Sandy, UT 84092
(801) 942-6529 (h)
(801) 533-4207 (b)

Utah Users
Quint B. Randle
255 N. 1600 W No. 76
Provo, UT 84601

Virginia
Rockingham, Augusta Co. area:
Andrew J. Milligan
314 N. Main St.
Bridgewater, VA 22812
(703) 828-2469 (h)
(703) 828-2623 (b)

Central VA User Group
J. C. McCormick
PO Box 29177
Richmond, VA 23229

Tidewater area:
Michael B. Williams
1300 DePaul Way
Virginia Beach, VA 23464
(804) 420-3308 (after 3 pm)

Hampton Roads T/S Users Group
Jim Langston
146 Hawthorne Dr.
Newport News, VA 23602
(804) 877-3920

Richmond area:
Walter E. Styles
PO Box 325
Chester, VA 23831
(804) 748-6082

Timex Users Group Roanoke Area
Capt. Jim Worthy
PO Box 1706
Roanoke, VA 24008
(703) 343-5335

SLUG
Gary Preston
Rt. 1, Box 21
Glade Hill, VA 24092

Roanoke Area Timex Users Group (TUG)
PO Box 1706
Roanoke, VA 24008
NL: *Racer*

Franklin County area:
Gary Preston
c/o C. Irvin
Rte. 1, Box 21
Glade Hill, VA 24092

West Virginia
Parkersburg area:
Gregory Wentzel
1209 36th St.
Parkersburg, WV 26104
(304) 428-5547

Groups outside the US

Belgium
Club ZX80/81
Chemin du Moulin 38
B - 1328 OHAIN
Belgium

Canada
Warren Imports Group
Warren Li, President
81 Brookmill Blvd.
Unit 80
Agincourt, Ont.
Canada M1W 2L5

Timex Sinclair Users Club
PO Box 7274, Station A
Toronto, Ont.
Canada M5W 1X9
NL: *Sinclink*. Membership Canada-wide.

Vimont Laval area:
Bill Walsh
125 De Piemont 2
Vimont Laval
Canada H7M 1B7

British Columbia
Timex-Sinclair Users Group of Vancouver
c/o J. Weidenbacher
691 Wilmot St.
Coquitlam, B.C.
Canada V3J 6P1

Costa Rica
The Computer Club of Costa Rica
Jess Peeler, Secretary
Apdo 41 Pavas
San Jose 1200
Costa Rica

Germany
Kaiserslautern
Germany ZX81 Users Group
Tom White
HG 21st SUPCOM
ACSRM - IRD
APO NY 09325
2221-7432

Spain
Club National de Usarios del ZX81
Avd. de Madrid, No. 203-207, 1.o, 3.a, esc. A
Barcelona 14
Spain

Turkey
Club Mediterranean ZX81
Mustaffa Sokullu
Istasyon cad., 43/8
Goztope, Istanbul
Turkey

United Kingdom
Educational ZX80/81 Users Group
EZUG
Highgate School
Birmingham
United Kingdom B12 9DS
NL

ZX Exchange
Nick Godwin
4 Hurkur Crescent
Eyemouth, Berwickshire
United Kingdom TD14 5AP
Informal postal contact with other users in U.K. and abroad. SASE and two international reply coupons.

ZX-Aid
Sinclair Users Club
25 Cherry Tree Ave.
Walsall
United Kingdom WS5 4LH
ZX80/1 User Group
G. E. Basford
9 Holme Close, The Pastures
Woodborough, Nottingham
United Kingdom NG14 6EX
Within the Nottingham Micro-Computer Club

Topical Groups

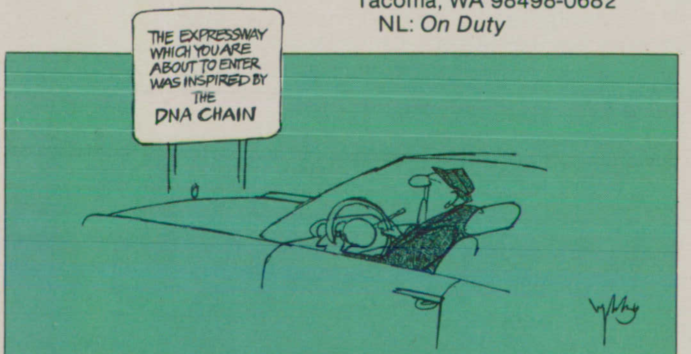
Stock market technical analysis:
Daniel Swenson
3439 Oakland Ave., S.
Minneapolis, MN 55407

Educational applications
M. Mark Wasicsko
School of Education
Texas Wesleyan College
Fort Worth, TX 76105

Business related
John S. Petralito
331 Winter St.
Bridgewater, MA 02324

Engineering
Bruce W. Bryan
521 Kelly Ave., Apt. D.
Pittsburgh, PA 15221

Military personnel only:
World Wide User Group
R. Smith
PO Box 98682
Tacoma, WA 98498-0682
NL: *On Duty*



Directory of Newsletters

Many user groups and individuals publish newsletters. The user group letters contain news about the group, its activities, programs, members, etc., but the main focus of all the newsletters is the exchange of information, programs, programming techniques, tutorials, product information, and user experiences. Some also accept advertising. They are usually mimeographed or offset printed on 8 1/2 x 11 paper (full size) or 5 1/2 x 8 1/2 (half size).

The newsletters that we know about are listed below in alphabetical order by name. The name and address of the publisher or sponsoring group follow. The size (full or half), the number of pages (this is approximate and often varies), number of issues per year/ annual subscription rate for U.S. residents (the cost of most group newsletters is included in group dues) are given where known.

The Computerist
Lanham Sinclair Users Group
Cora C. Dickson, Editor
9528 Elvis Ln.
Lanham, MD 20706
(301) 577-6645

The Computer NEWSletter
PO Box 952
Cleveland, OH 44120
(216) 283-8871. Full; 12 pp. 10 times/$17.50. Specify computer. References and categorizes computer related articles from over 50 publications.

Computer Users Group Timex Sinclair 1000 & ZX80/81 Newsletter
Peter Wolcott
305 West 51 Terr.
Kansas City, MO 64112
(816) 753-8546

EZUG
Educational ZX80/81 Users Group
Highgate School
Birmingham
United Kingdom B12 9DS

Friendly Newsletter
Friendly Computer
Box 122
Wellingford, PA 10986
(215) 872-2061. SASE for free issue.

Keyboards
Timex and Sinclair Bay Area Microcomputer User's Group (TAS BAM)
PO Box 644
Safety Harbor, FL 33572
Full; 6 pp. Frequency and rates TBA.

Microcomputer Home Control Newsletter
Chesapeake Systems Corp.
PO Box 546
Columbia, MD 21045
4/$9.97. Hardware and software applications in home control, security, communications.

Mile High Chapter T/S Users Newsletter Peter J. Callinicos, Pres.
12026 W. Virginia Pl.
Lakewood, CO 80228
(303) 986-4843

Newsletter for children
Chris Baldwin
Sinclair Study Group
16 Lewis St.
New Haven, CT 06513
12/$6.

QZX
c/o Alex Burr, KSXY
2025 O'Donnell Dr.
Las Cruces, NM 88003
$12. For amateur radio and TS/ZX computer users. Meetings on the 20 meter band; about 14.346 MHz on Wed., 10 p.m. EST.

Racer
Roanoke Area Computer Enthusiasts
PO Box 1706
Roanoke, VA 24008

Sinclair-Timex User Group Newsletter.
Sinclair-Timex User Group
The Boston Computer Society
Three Center Plaza
Boston, MA 02108
(617) 367-8080
Full; 8 pp. Monthly.

Sinclair Users Group Newsletter
c/o George Repicky
49 Roosevelt Ave.
Schenectady, NY 12304

Sinclarion
Sinclair/Timex TS/ZX S.I.G.
PO Box 25599
Chicago, IL 60625

SincLink
South Bay Timex/Sinclair Users Group
Paul D. Perreault, Dir.
947 Clara Dr.
Palo Alto, CA 94303

Sinclink
Timex Sinclair Users Club
PO Box 7274, Station A
Toronto, Ont.
Canada M5W 1X9
Membership Canada-wide.

SINCUS
Sinclair Computer User's Society
PO Box 36
Johnson City, NY 13790
Full; 10 pp. Monthly.

"SIN-TIME" Review
PO Box 742163
Houston, TX 77274
(713) 771-9924
Half; 16 pp. 6/$12.

Software Market Letter
National Association of Free-lance Programmers
PO Box 813
Vienna, VA 22180
12/$48. Membership in NAFLP includes *SML*. Software marketing information and advice; where and how to sell programs; how to get contracts for free-lance programming; tutorials.

S.U.N.
Sinclair Users' Network
2170 Oak Brook Cir.
Palatine, IL 60074
(312) 934-9375
Full; 28 pp. 12/$16.

Synchronizing Education and Games
Synchronizing Education and Games
688 Sherene Ter.
London, Ontario
Canada N6H 3K1
(519) 471-9089

SyncWare News
Syncware Co.
PO Box 5177
El Monte, CA 91734
Half; 20 pp. 12/$15.

SYNTAX
The Harvard Group
Bolton Rd., RD 2
Box Box 457
Harvard, MA 01451
(617) 456-3661
Full; 24 pp. 12/$29.

TEC News
Timex/Sinclair Educators User Group
M. Mark Wasicsko
Associate Dean
School of Education
Texas Wesleyan College
Ft. Worth, TX 76105
Free to educators. Applications of low cost computers to education.

Timelinez
Association of Greater Bay Area Timex User Groups
c/o Paul Perreauult, Organizer
947 Clara Dr.
Palo Alto, CA 94303

TSUG Newsletter
Triangle Sinclair Users Group
c/o Douglass Dewey
206 James St.
Carrboro, NC 27510
Full; 6-8 pp. Monthly.

TS User
Yagsee
PO Box 155
Vicksburg, MI 49097
Full; 12 pp. 12/$16.95.

TUG-LINES
Roanoke Area Timex Users Group
PO Box 1706
Roanoke, VA 24008

T.U.G. Newsletter
Timex User Group of Marietta, Georgia
c/o Hubert Crowell
3105 Mary Dr. N.E.
Marietta, GA 30066
Monthly

Westinghouse ZX80/1 Users Club Newsletter
Jack Fogarty
Westinghouse MS 3525
PO Box 1521
Baltimore, MD 21203

XFORTH XCHANGE
c/o Hawg Wild Software
PO Box 7668
Little Rock, AR 72217
Forum for users of XFORTH; unscheduled.

Z-West
PO Box 2411
Vista, CA 92083
(619) 757-1387
12 pp. 12/$20.

ZX80 Southeast Region Club Newsletter
Ralph Coletti, Pres.
869 Levitt Parkway
Rockledge, Fl 32955

"... We could go to a movie, but I'd rather generate graphics on our home computer."

The Aerco Disk Drive System *Paul B. Caley*

The Question

Disk drive or no disk drive? That is the question. Or, rather, it was the question. I looked long and hard at all the options and decided to stay with my Sinclair and to add the Aercò floppy disk interface and disk drive to my miniature computer. Many of you out there in Sinclairland are wrestling with the same questions. Let me tell you about my choice and about the happy results.

About a year ago when I put together my $99 handful of hardware the little mite worked. Though I did not know the difference between LIST and LET, I laboriously worked on the miracle membrane. By summer my knowledge had increased and I decided to double my investment by adding a box of Byte-Back parts which gave me a neat 64K memory. By fall I had acquired useful software: a data base (*The Fast One*) and a word processor (*Z-Text/L-Text*) from England. I had begun to use this little wonder in a small (church) office.

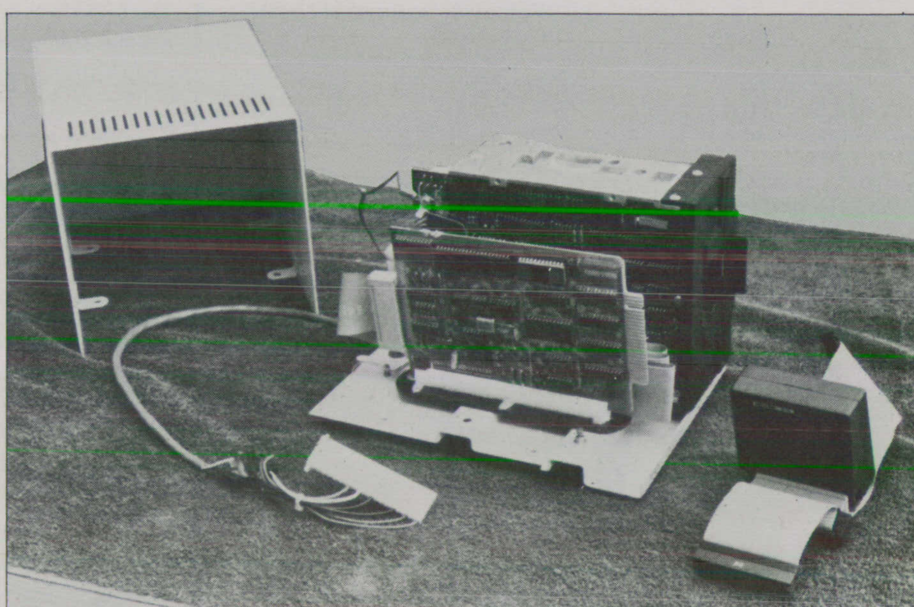


Photo 1. Complete Aerco Disk Drive with connecting cables and 16K RAM pack.

My part-time secretary politely balked at the toy keyboard when I showed her how to use it. The result was that the original investment increased again when I bought a $25 surplus keyboard, a few diodes, wire, and connectors to attach it to the computer. At least it worked, and it worked well.

Horizons continued to lift. Uses for the expanded Sinclair loomed into view beyond all dreams. By winter I needed a good quality printer to create labels for my mailing list of 250 names and to do lots of other printing. At this point I made an important decision. I would buy the printer as long as I could use it later on with a "good" computer as well as use it now on my "Rube Goldberg." I was into this whole project to the tune of about $250 for hardware. I added double that investment by getting a Memotech parallel interface and a Prowriter printer. Even though I had now spent $750 for hardware, I knew that my $400 printer could be used later with a "real" computer. From now on I thought I should keep my eyes for the Sinclairland exit door.

New problem: My data base had grown to the point that to load a program took nearly 20 minutes; using the word processor meant a 10 minute wait. Not that one cannot wait and do other things during long LOAD and SAVE times, but what about a disk drive?

The Disk Answer

This decision required a lot more thought and comparison than my printer decision. I could buy a "suitcase" computer and have a neat, integrated unit with lots of super software. I looked, read, talked around, and came to these con-

Paul B. Caley, RD 1, Box 56, Duanesburg, NY 12056.

The disk drive whirrs a few seconds, and stops. You have just written the contents of your computer's memory onto page 1 of your disk.

clusions: 1) I do not have $1800 for a suitcase computer; 2) My Sinclair does what I need a computer to do; 3) If I buy the right disk drive, I can use it later on a "real" computer.

So I sank another $450 into that $99 Sinclair (which today can be bought for $39, and you get it assembled for the price, too!) on the Aerco floppy disk drive system.

The Aerco Disk Drive

The disk drives sold by Aerco are Pertec FD 250 units. Any Shugart type drive could be used, but at $189 each from Aerco I felt this was the best price around.

The Aerco disk drive unit transfers data at a rate of 250,000 bits per second. Disks (soft sectored, double density, double sided) accommodate 320K. This is considerably faster and a much larger volume of data than is reported for the F12-Floppy and the cost is comparable.

The Interface

The disk interface is a 4 1/2" x 6" uncased printed circuit board. A 12" ribbon cable attaches between the back of my 64K memory pack and one end of the interface which has a mating edge connector. For someone with the Sinclair memory pack which does not have a rear edge connector access, the 12" ribbon cable has a female connector midway down its length that accepts the memory pack. You then plug the computer end of the 12" cable directly into the back of the Sinclair.

A second ribbon cable (3' length) plugs into an edge connector on the opposite end of the interface. This cable has two female connectors at the far end. These connectors are about 4" apart. You plug either one of these connectors into your disk drive. The extra plug is for a second drive. Actually, you can connect up to four disk drives to this interface. All you need do is to add two more connectors onto the 3' cable.

The Aerco interface is equipped with 17 integrated circuit chips, one of which is an EPROM that is used in disk formatting. Also provided is one 5 1/4" disk containing the systems monitor.

The Power Supply

Power supply required for the interface and drive is +5 volts and +12 volts. Aerco sells a power supply for $60, but I decided to save a little at this point. I bought a 3 amp regulated, filtered surplus 5V/12V/24V unit mail order from John Meshna & Co. in Boston for $20. (This is the same place I had earlier bought my keyboard). For $7.50 I bought a power supply cable from Aerco with a plug that fit the disk drive. There is an extra plug on this cable to power a second disk drive should one ever be added. Also I dropped the 12V to 9V so that I could use this new power supply to power the computer.

The Finishing Touch

To finish off the unit, I bought a disk drive cabinet for $35 from Aerco. It accomodates two drives, mounted vertically. Since I only have one drive, I plan to install the interface card in the vacant side of the cabinet.

Using the System

When I first hooked up the system, I had trouble getting it to operate. I got a "DISC ERROR" report on the monitor each time I tried to load the system. So I picked up the phone and put in a call to Aerco and got Jerry who walked me through a diagnosis process. I reported each thing that happened, and he was able to diagnose the problem right then and give me the fix over the phone. What happened was that a mechanical link between one of the drive motors and the arm which moves the recording heads across the face of the disk had become disconnected during shipment. All I needed to do was to rotate the motor by hand for one turn. This re-connected it. (Later on when I read the disk drive manual that came with it, naturally I found out that this was covered in the manual!)

It was really great to see this thing come to life and to be ushered into the world of a "real" computer, Sinclair and all. After the system was booted and the disk formatted, I was now ready to take programs that previously had been stored on tape and put them onto the disk.

It works this way. First, load a program into the Sinclair. Then, get into command mode and initialize the disk drive by typing RAND USR 12865, and ENTER. This process brings the disk drive to life and on-line. Next, with a formatted disk in the drive, type RAND USR 12721 and ENTER. The disk drive whirrs a few seconds, and stops. You have just written the contents of Sinclair memory onto page 1 of your disk.

Now for the acid test: press the re-set button (which hangs from a wire on your disk drive interface). When the cursor appears, type RAND USR 13303 and ENTER. Up pops a menu on the video screen with six choices. Type L for List

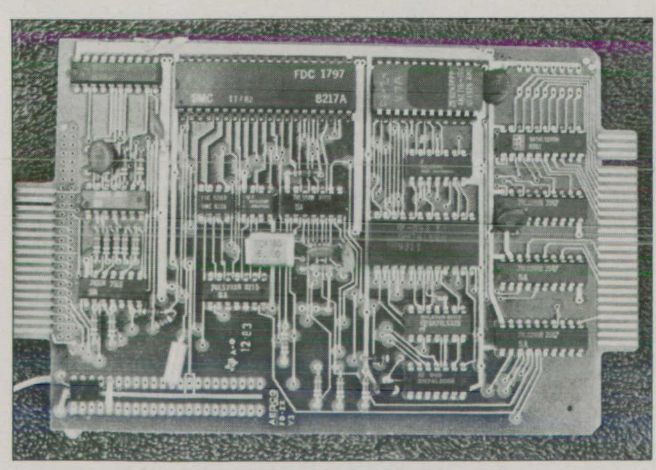


Photo 2. Component side of disk interface board.

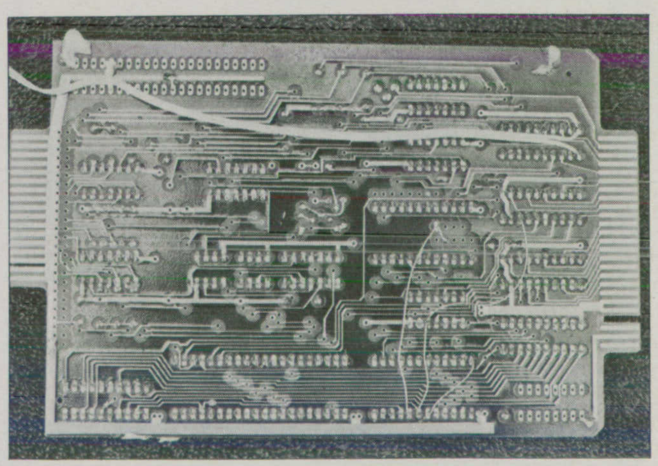


Photo 3. Bottom side of disk interface card.

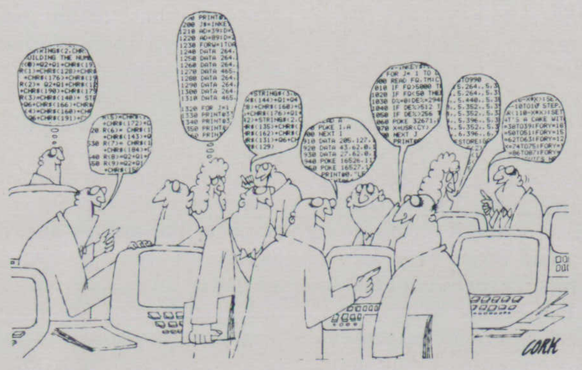
Directory. Up pops a Directory with 16 choices (16 pages). Type 1 for page 1. Up pops your program. I like it.

But one problem: I had no difficulty loading my programs onto disk except the one program that took 20 minutes to load by cassette tape. This disk drive would not work with the very program for which I had bought it! Idea: call Aerco and talk to Jerry. No, first, try to figure out why it will not work. Ah, yes, each side is divided by the formatting process into 8 pages. 160 divided by 8 means that each page can only acccommodate 20K. And my master data base contains nearly 40K! No wonder it would not load. *Now* call Jerry at Aerco!

Jerry said he would write a routine to accommodate my 40K program. I sent him an extra $10 for the service. A week later he called me back to let me know a new EPROM was on the way and that all I had to do was to switch the EPROM on the interface card. I could now format pages in two ways: disks with 16 pages at 20K each or disks with 6 pages at 53K each. Problem solved!

Conclusion

Complaints? Only the common one that all of us novices have: more documentation, *please* (but Jerry knows the need for this). Pete, my 15 year old son, and I (mostly Pete) were able to figure out how to do things, even if the documentation did not tell us. Otherwise, a phone call was all that was needed, and Jerry will talk to you.



I have found my dealings with Aerco to be a delight. Jerry has now become a friend. Sometimes shipments may be slow, (I did have to wait for some deliveries), but, when I decided to order the disk drive from him, he shipped it the same day I called. I had not called him till 4 p.m.! I cannot say enough good about the way I have been treated at Aerco. Besides, their product is good, and well-supported by them.

I like my Aerco-Sinclair, (or is it Sinclair-Aerco?). I like the rapid LOADs and SAVEs. I like having the contents of 16 cassette tapes now on one disk. I like the fool-proof transfer of data. I have not experienced one failure in data transfer.

So if you have long programs, do not fear staying in Sinclairland. At a total hardware cost of $1300 I have a 64K disk system with 9 x 9 dot matrix printer, with a used video monitor that meets my needs. If I ever opt for out, I take my monitor, printer, and disk drive with me and that is $900 of the $1300. Not a bad deal!

Cyborgwars *Peter and Eric Hoffman*

Cyborgwars is a strategic game in which four warring cybernetic empires each call upon a human leader to take control and become the supreme leader. This game is the managing an economy, resource allocated type. The resources, in this case, are the robots themselves.

The empires are based on a hierarchy of robots: breeders, farmers, workers, and, at the bottom, soldiers. Each robot type may be freely converted to a lower type (for example, a breeder to a farmer), but not the reverse.

The breeders manufacture more breeders; farmers raise crops for rations; workers make armaments; and soldiers defend the realm (or attack other realms). Food production depends on the number of farmers and acreage of land held. Random disasters can damage crops, stored rations, and weapons. Spies may be dispatched to, perhaps, learn the strategic situation in the other empires.

Peter and Eric Hoffman, 5618 Martinique Dr., Corpus Christi, TX 78411.

SYNC

SOFTWARE PROFILE

Name: Cyborgwars

Type: Resource allocation game

System: 8K ROM; 16K RAM

Format: Cassette

Summary: A fun strategic game for up to 4 players.

Price: $14 plus $1 s&h

Manufacturer:
Strategem Cybernetics, Inc.
286 Corbin Pl., 2E
Brooklyn, NY 11234

The program is loaded in two parts to allow selection of a secret password for each human player. Each player is required to enter the password at each turn. The program is all text output with no graphic displays. Several copies of a form for recording strategic data are provided.

The senior author played the solitaire version with the computer playing the other three opponents. It takes careful planning and some luck to win. The computer does not cheat, but, after you get thoroughly stomped the first few times, you get the feeling that there is a conspiracy by the computer controlled players to attack only *you*. This could easily lead to paranoia.

The junior author play-tested the game with several friends who are all experienced fantasy role-playing gamers (i.e., D & D'ers under age 15). They are used to cooperating in game play, unlike the usual winner-take-all demands of most games. Cyborgwars allows the game to end amicably with the largest regime being the "winner" if a sufficient number of turns has passed with no military action occurring.

We consider this a good strategic game. It does not depend upon reaction time or hand-eye coordination. Although it takes a long time to play, it is fun.

The Timex/Sinclair 2040 Personal Printer

Randall S. Glidden

The Timex/Sinclair 2040 Personal Printer. $99.95. Timex Computer Corporation Waterbury, CT 06725.

After a long wait, the Timex/Sinclair 2040 Personal Printer is finally available in the United States at most outlets that carry the TS1000. However, there is both good news and bad news with regards to this little beauty, I'm afraid.

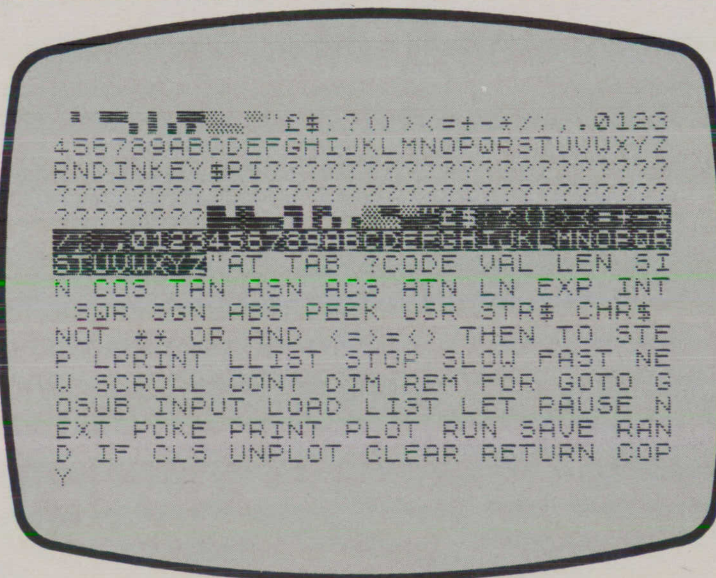
First, the good news. At $99.95 (or less if you shop around) the 2040 is the cheapest printer on the market designed specifically for the TS1000 or ZX81. Although it is by no means comparable to an 80 column, 8 1/2 inch paper cruncher, its 4 inch, 32 character format is adequate for its intended purpose, to produce legible hard copy of displays and program listing.

The package consists of the printer's own separate 24 volt power supply and the printer unit itself. A short cable connects the printer to its edge connector interface which plugs into the rear of the computer. A male edge connector extends from the back for interfacing with the 16K RAM pack or other peripherals in a piggy-back fashion. The chasis is a bit larger than that of the Sinclair printer (i.e., the British predecessor).

To operate the printer there are but two switches: "on/paper advance" and "off." All you have to do is load the paper (one free roll included), plug the printer in, press the "on button" and you are ready to print.

The rest of the operation is controlled by the three keyboard commands: LPRINT works exactly like the PRINT statement, printing on paper whatever follows the command. LLIST will list your entire program in the familiar LIST format. COPY (used usually in the immediate mode) will print whatever happens to be on the screen at the time.

Figure 1. Printout of the Character Set.



A built-in self-testing routine (activated by presssing "off" while holding the on/advance confirms the proper operation of the printer's innards by printing row after row of 8's and 1's.

The cable from the interface to the printer carries only seven lines: printer select, D0, D6, D7, RD, WR, and Ground. Printer select is generated in the interface itself with a single 74LS10 clip which pulls printer select low (i.e., enables printer operation) when A7 is high, A2 is low (=FBh), and IORQ is low. The printer, incidently, works as an I/O port as far as the Z80 microprocessor is concerned, using OUT (FB), A and IN A, (FB) commands.

The 25 meter rolls of thermal printer paper retail for 3 for $5.95, but availability has not been that good, at least in the Boston area. I suspect this should improve with time as distribution becomes more wide spread.

The printing operation itself is relatively quiet, fairly fast (about two lines per second), and very clean and legible. Figure 1 shows a sample printout of the character set.

I have found it extremely handy for printing out listings and machine code routines. Debugging is much more readily accomplished on a paper copy than on a screen only 24 lines long.

So, in summary, the good news *is* good: the TS2040 is a sophisticated, yet simple and reliable little machine that any serious user should consider.

Now, the bad news. By the time this review is printed this may be old news, but when I bought my printer (May) I was disappointed when my Byte-Back 64K

Randall S. Glidden, M.D., 185 Chiswick Rd., Brighton, MA 02135.

An inexpensive alternative to a full-size line printer, a good value for the money, and a worthy ZX/TS companion.

RAM would not function in the upper 32K area with the printer attached. It worked just fine in the usual 16K area, but even with the printer unplugged it would not accept poking RAMTOP to 6535.

This problem is not confined to the Byte-Back RAMs only, since Memotech 32K units have had a similar problem (and I would imagine others have as well). When I called Byte-Back, they were aware of the problem and had it solved within a week or two. It seems that in order to pass FCC interference regulations Timex made some rather unorthodox circuit adjustments that had the effect of slowing down signal transmission times on the data bus. This helps decrease unwanted RF emissions from the printer, but it also leads to a bus conflict that may cause problems with memory devices that pull ROM CS high to utilize the 8-16K and 32-48K memory areas (where the ROM repeats itself).

Timex's response to this problem has been sort of a "tough luck Charlie" attitude, since their 16K RAMs work just fine thank-you. The problem, however, is not insurmountable. Byte-Back gave me a very simple circuit modification to do which resulted in the speedy resolution of the situation.

Since each company probably uses slightly different decoding routines in the RAM, I suggest that those of you with 32K or 64K units consult your manufacturer as to how to perform the necessary modificatioms. By now most of them should have figured out a way around Timex's little adjustment, but I give Byte-Back a big pat on the back for being one of the first companies to solve this problem. (Incidentally, if you have one of the imported Sinclair printers I understand that there is no high-mem pack incompatability, and you should have no problems combining the two in your system.)

The FCC faux pas aside, the 2040 is an inexpensive alternative to a full-size line printer, a good value for the money, and a worthy companion for your Timex Sinclair computer.

Computer Battlegames and Computer Space Games

Ed Hoornaert

Computer Battlegames and *Computer Spacegames* by Daniel Isaamen and Jenny Tyler. Hayes Books. $4.95 each (Canadian).

My kids like computers. Four-year old Chris enjoys banging on the keys. Seven-year old Scott likes games, but is also quite interested in programming. He will work hard and long trying a program of his own, or typing in a program from a book or magazine. Unfortunately, there are few books for young users like Scott. So this pair from England is all the more welcome for ZX/TS users.

Computer Battlegames and *Computer Spacegames* share the same format. The heart of each book consists of listings of about a dozen short games. Each listing is designed to work on a ZX81 or Timex Sinclair 1000, but "translations" are included for the Spectrum, BBC micro, TRS 80, Apple, and Vic 20. There are also brief sections about adding to the programs, writing your own programs, and a summary of Basic.

Every effort has been taken to make the books attractive. The full color illustrations are very well done. The inevitable cute little robots appear throughout the books, making program operation clearer or challenging the child in the Puzzle Corner. All in all, the books are quite appealing.

However, what is underneath the flashy appearance?

The programs themselves—Robot Missile, Battle at Traitor Castle, etc.—are very simple, text oriented games that in no way live up to their illustrations. After all, most of them are designed to run in 1K—and *SYNC* readers know that this means the user must supply a lot of imagination!

I believe this simplicity is intentional though. Your child will probably spend as much time and get as much enjoyment from entering the programs as from playing them. The listings are essentially educational—in a fun way.

What, then, can your child learn from these books?

Let's start with what the child will not learn. The books do not attempt to be a course in Basic, so he will not learn everything he needs to know about programming. He will not learn how to operate that unique Sinclair keyboard—so be prepared to help out.

Your child will learn how these computer games work. The programs are all thoroughly explained. Once again, though, be prepared to help out unless your youngster has a good computer background. Your child will also probably learn ways of improving and changing the games because of the many hints and suggestions. After all, the programs are deliberately simple so that their operation is clear. The books encourage the child to think rather than just blindly type in a listing. And this is really the best thing about *Computer Battlegames* and *Computer Spacegames*—even better than the pictures!

Ed Hoornaert, RR2, Box 3206, Clearwater, B.C., Canada V0E 1N0.

hardware tips

For our "Hardware Tips" department we have asked Robert Hartung to comment on some letters from our readers. Since he had only the information given in the letters to work with, he cannot guarantee his answers. Rather his responses should be regarded as suggestions to help look for the answers. In most cases more details would be required in order to give a fuller answer. Any hardware changes are undertaken strictly at the reader's own risk. We welcome comments from readers on these problems also.

LOADing Problems

Recorder Output

I have been unable to load with a GE 3-5105 recorder or a new Panasonic even after trying all the suggestions in Sinclair's "Loading and saving with your ZX81 Computer." According to Sinclair's technical note, the recorder must output 5-6 volts. The GE output had 2-3 volts, and the Panasonic 2.5 volts. I believe this is the problem. However, the TV screen does go through the loading sequence.

C. D. Tuttle
5821 Natural Bridge
St. Louis, MO 63120

Comment:

I have had good results on three ZX computers using a very ancient Lafayette as well as Radio Shack CTR-41, CTR-57, and GE 5005 cassette recorders. So the fault may not lie in the recorders you have tried.

An LED connected across the two leads of the LOAD cable at the EAR plug lugs should be lighted when a program tape is played back for LOADing, with only occasional flickers.

If this checks out OK, then it is possible there is inadequate filtering of the DC power to the computer, or that your particular ZX81 is sensitive to the voltage drop imposed by the additional load of the RAM pack.

SAVE a program to tape, then play it back at normal volume through the cassette player speaker. If in the 5-second silent lead-in portion you hear a high-pitched whistle, similar to the horizontal-sweep frequency of a TV, this oscillation may be masking out the program signal or over-riding the auto-level circuitry used in most portable recorders. If you can SAVE and LOAD all right with the RAM pack detached, connecting a 2200 uF 35 WVDC capacitor between the DC power cord leads, observing proper polarity, might raise the effective RMS voltage enough to stop the oscillation interference.

LOADing problems can also occur with program tapes which have been over-modulated in recording or in copying to the extent that a sharp definition is lacking between the rise and fall of signal pulses. Too high a playback level will also cause LOAD defaults. An LED shunted across the LOAD cable leads will show this as a steady brightness with little or no flickering. Tape dropouts are indicated by an interval of reduced brightness as compare with the preceding and following portions of the same program SAVE.

Recorder Leads

Initially I had to disconnect one or the other cassette lead when LOADing or SAVEing. I got rid of the interference problem by *carefully* slitting the molded plastic buttons joining the leads and separating them.

Andreas Rainwater
Rt. 1, Box 57-A
Coyle, OK 73027

Comment:

Some cassette recorders create an audio-feedback groundloop with both LOAD and SAVE cables plugged in. A 4P4T slide switch in a small metal box with plugs and jacks between the cables and cassette recorder and an external mike is a great convenience.

Keyboard Problems

The BREAK/SPACE Key

Is there a hardware modification to remove the BREAK command from the SPACE key? This combination is extremely inconvenient at times, especially when using the INKEY$ function.

Mike Swanson
Box 179, USACC-J, SB
APO San Francisco 96331

Comment:

The only hardware required for the following routine is a dime over the SPACE/BREAK key (or a penny if you are broke). A conditional transfer or a RETURN line may be added after line 40 if this is a part of a main program or is a subroutine.

```
 10 REM USE ENTER/NL FOR SPACE
 20 PAUSE 40000
 30 IF INKEY$=CHR$ 118 THEN PRI
NT "#";
 40 IF INKEY$=CHR$ 118 THEN PR
INT INKEY$;
 50 GOTO 20
```

Line 40 can also be:

```
 40 IF INKEY$=CHR$ 64 THEN PR
INT INKEY$;
```

This prevents unintentional printing of token words although it is interesting that the INKEY$ function treats the image quotation mark (SHIFT Q) the same as the quotation mark (SHIFT P).

Shift lock

I made a shift lock using a Radio Shack SPST soft feel push on/push off switch (275-1565). I bored a hole through the left edge of the keyboard just above and to the left of the shift key. There is a small key free area there. I located the proper pins on the keyboard ribbon connector and soldered a wire to the underside of each. Two ribbon cables come out of the keyboard. The left consists of 5 ribbons; the right, 8. I soldered one wire to the rightmost of the left group and the other to the third from the right of the right group. Knowing this beforehand will bypass the need to peel off the keyboard for a look. After putting the switch in the hole, I soldered the wires to it.

Andreas Rainwater
Rt. 1, Box 57-A
Coyle, OK 73027

Attaching Keyboards and Joysticks

What is the simplest method of attaching a keyboard and a joystick to the ZX81? How does a ZX81 user know whether a source is reliable and will ship merchandise in working condition? Will ZX81 hardware/software fit the Spectrum?

Arthur F. Jenson, Chaplain
Office of the Staff Chaplain
US Military Community Activity Augsburg
APO New York 09178

Comment:

Reputable suppliers of keyboards and joysticks will provide full instructions for their products. If possible, use a charge card for mail-order purchases. If they do not deliver, the bank tells them you do not have to pay until they do. The ZX printer is compatible with the Spectrum, and loaders are being advertised which will transfer ZX programs from tape into the Spectrum.

KBD Signal for TS1000

I have assembled the circuit for the "Repeat Key Option" in George R. Ingle's article in *SYNC* 2:5, but I need to know where to pick up the keyboard signal (KBD) on my TS1000.

Paul W. Stuehn
31690 Cowan, A12-205
Westland, MI 48185

Comment by George R. Ingle:

Although I do not have a "true" ZX81, the repeater should work on the newer machines since they use the same keyboard scanning hardware/software that the MicroAce and ZX80 used.

To connect the repeater to a ZX81, follow the instructions in the original article with the following exceptions:

1) On the ZX81 the keyboard diodes are numbered D1-D8.

2) The ZX81 does not generate an external keyboard enable signal. This is performed by IC1, the SCL.

3) Connect the 74LS02 as shown in Figure 1. This shows a simple circuit which should generate the KBD signal required by the 74LS44 buffer to operate the keyboard normally for the ZX81 and TS1000.

Power Supply Problems

Overheating and Crashes

In West Germany the OEM adapter we got with the ZX81 becomes very hot within just a few minutes of use. We have to use a 500 watt transformer which in turn plugs into our 220V wall socket. Is this heat responsible for the many program crashes we experience? Is there any way to minimize the heat? What do you recommend to minimize or eliminate constant program crashes? I have looked at QSAVE and the Baby BBU.

Arthur F. Jenson, Chaplain
Office of the Staff Chaplain
US Military Community Activity Augsburg
APO New York 09178

Comment:

The best approach for the power supply problem probably is to build your own. Obtain a 220V/9V or 220V/12.6V transformer of at least 1.5 to 2-A rating. Connect a 4-A 100 PIV bridge to the output of the transformer. Connect a 4400 uF or 5000 uF 50 WVDC filter capacitor across the DC leads of the bridge, observing proper polarity. Run the output of the bridge through a 7805 voltage regulator set for 9V as shown in *SYNC* 3:2, p. 68 (isolate the regulator from heatsink and ground and insert a 680 resistor in series between the ground lug and ground (-) for 9V only). Include a 1-A inline fuse in the AC input to the transformer.

The most common answers for the problem of crashes are covered elsewhere in this column: Make sure you have good connections with the RAM pack; use a regulated, well-filtered power supply to elminate problems from the power source, unless you have main power outages, of course; preregulate the DC power to the computer to prevent component overheating.

Loose Plugs

The cable plugs and power supply line are always loose. Is there any source of male plugs (with screw threads) that fit the UK jacks?

K. D. Streetman
Mail Stop 263, PO Box P
Oak Ridge, TN 37830

Comment:

Standard mini-plugs, such as Radio Shack 274-286 or 287, will fit the jacks better, in fact, than the originals I received with my computer, which were a bit too long for the jacks.

An in-line switch in the DC power cord, such as the Radio Shack 61-2713 suggested by Andreas Rainwater, will save wear-and-tear on the jacks.

For my own setup, I have the computer power supply, TV, and two cassette recorders plugged into a switched powerstrip, with a lever-type microswitch at the computer as a "panic-switch" when a trial ML routine crashes or takes off to cloud cuckoo land.

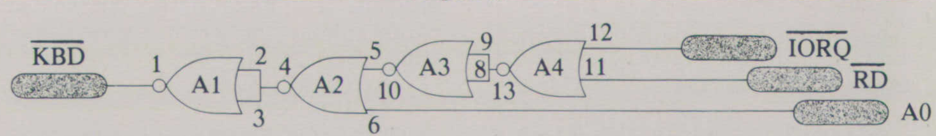
Plugs and on/off

The power plug seemed to be wearing rapidly due to the lack of an on/off switch. Installing a lamp cord switch on the line provides one. The power cord is not large enough to be pierced by the prongs for installation; it must be pushed onto them. The switch should be available for less than a dollar at most discount houses. I used a Radio Shack 61-2713A.

Since the 7805 IC (voltage regulator) works fine on any input voltage from 8-20VDC, a special portable or uninterruptable power supply is not needed. The computer can run directly off any 12V battery. At home one can use a battery in conjunction with a small trickle charger as an uninterruptable power supply. The jack plug on the Sinclair is tip positive like most 9V plugs. It is a good idea to add a 3A diode in line for safety's sake. If you plan to use the computer in such a configuration for any extended period of time, it is a good idea to externalize the 7805 as Stephen Turner did (*SYNC* 3:1). Running on 12VDC clears up the display so well that it is worth doing for that reason alone.

Andreas Rainwater
Rt. 1, Box 57-A
Coyle, OK 73027

Figure 1.



Pin 14: +5V (Vcc)
Pin 7: 0V (Vdd)

ICA	74LS02 QUAD NOR, 2 INPUT	RD	Connect to IC3 Pin 21
IORQ	Connect to IC3 (Z80 CPU) Pin 20	A0	Connect to IC3 Pin 30

Comment:
These suggestions are good, but there is one major problem: If the power mini-plug were to be connected to or disconnected from the computer jack with the full amperage of the battery applied across the jack contacts, the results could be disasterous. An in-line 1A fuse with an external 7805 voltage regulator, or at least the fuse, should be added in the power line from the 12V battery for short-circuit protection. The on-board 7805 should be left in place and the out-board 7805 adjusted to 9V by floating (isolating) its mounting tab from ground and inserting a 680 resistor in series between its ground lug and ground (-). See *SYNC* 3:4, p. 68. While the 7800, 317, and 350 types of voltage regulators do have built-in thermal and short-circuit protection, I have had them fail into a dead short internally along with the filter capacitor of a power supply when subjected to voltage spikes from repeated switching transients. A fuse is very cheap protection.

Regulated Voltage Questions
These questions have arisen in response to my article on "A Regulated-Voltage Power Adaptor" (*SYNC* 3:2).

Question: Is it safe to switch from one voltage to the other with power applied to the computer?

Comment:
Because the pre-regulator limits voltage input to the onboard regulator to 9V maximum while the unregulated VDC from your AC adaptor may attain peaks of 13V (or higher transient spikes) when the power plug is withdrawn and reinserted, the pre-regulation provides protection for the onboard capacitors and other components which are rated for 16V.

Question: Why is switching to a higher voltage for SAVE suggested when my computer SAVEs and LOADs at the lower voltage?

Question: Is the on-board regulator still used?

Comment:
I suggested the 7-9VDC pre-regulating adaptor for two reasons:

1) Since some users may not want to make any changes inside the computer while using a variety of alternative DC power sources, most of the voltage-regulation heat must be dissipated outside the computer. The 5V on-board voltage regulator *must* be used with this adaptor when the 7805 or LM-350T regulators are set as described, but the on-board regulator may be removed, *subject to the following exception:* if the adaptor regulator is set to exactly 5V.

2) If the unregulated power input to the computer jack drops below 8.5-9VDC during the SAVE mode, some 16K RAM packs, such as the Sinclair with voltage-regulation on-board the pack, may develop a high audio-frequency oscillation. This may interfere with the SAVE program signal on some tape recorders by drifting in frequency into the upper range of the audio signals being recorded. Some packs crash or cease functioning altogether.

Interfacing Problems

The ZX Printer and a Vic-20
Is it possible to interface a ZX Printer to a Vic-20?

Brent Myers
PO Box 564
Tuscarawas, OH 44682

Comment:
It is possible to construct circuitry to interface any printer to any complete computer. However, the ZX printer is designed to receive output of the actual character dot patterns through the I/O port of the ZX/TS computers while most other printers are designed for standard ASCII codes. I do not have any information on interfacing it with the Vic-20, but perhaps some *SYNC* reader has done this.

resources

The "Resources" column lists new products and services for users of Sinclair and Timex Sinclair computers. Suppliers and users are invited to send brief product descriptions including software format and details for ordering to: Resources, SYNC Magazine, 39 E. Hanover Ave., Morris Plains, NJ 07950.

All programs in this listing require the 8K ROM and 16K RAM unless otherwise noted. "CC" indicates cassette format.

Loading Aids/ Accessories

Cassette Recorder Alignment Tape

Helps align mono cassette recorder head for best results, check tape speed and path. Jeweller's screwdriver is the only tool needed.

Hilderbay Loading Aid

Get the loading volume just right the first time every time; usually finds dropouts; compare the quality of different makes of tape; locate tape files on tapes with several files. Plug into ear socket of computer; plug ear lead into HLA.

Hilderbay, Ltd.
8/10 Parkway
Regents Park
London NW1 7AA, U.K.

Assemblers/Disas - semblers/Compilers

TS1000/ZX81 Disassembler

Displays and prints disassembled listings or hexadecimal dumps. Disassembles full instruction set using standard Zilog mnemonics. Memory examine, search and modify. LOAD and STOP any program for disassembly or backup. Occupies 3.5K. MC utility; loads anywhere in memory. CC and instructions: $14.95 pp.

Scientific Software
6 W. 61 Terr.
Kansas City, MO 64113

Assembler in Basic

Provides for use of labels, absolute jumps, relative jumps, variables, text, some expression evaluation, and editing of original assembly text (stored in REMark statement). "Double-pass" assembler. Enter mnemonics with op codes. Cannot handle IX or IY commands; modifications pending. 3 page listing: $1.50 plus long SASE.

John Richard Coffey
PO Box 448
Scottsburg, IN 47170

Printers and Aids

Screen Copy Program

Allows Spectrum screen to be copied onto a Tandy CGP-115 four color printer/plotter when used with Softest CGP-115 interface. Scans screen horizontally and sends printer information to Tandy printer. Colors mapped to printer's four colors. Program: $15; interface: $75.

Softest
10 Richmond Ln.
Romsey, Hants
U.K. SO5 8LA

PI2040 Printer Interface
PC2040 Printer Cable

Solves the interface problems of connecting the TS2040 printer to a TS1000 computer with Memotech and other non-Timex add-ons; tested with all Memotech products and several other add-ons not compatible with the TS2040; comes with PC2040 36" flat ribbon cable; expansion connector for add-ons. $37.50 plus $2.50 s&h. V/MC orders: 1-800-458-5858, x577 (in CO: 1-800-458-4545, x577).

Compumentor
Suite 405, 1919 14th St.
Boulder, CO 80302

Boards/Interfaces

Brother EP-20 and TS1000

Adapt a Brother EP-20 electronic typewriter for use as a ZX printer. Schematics and information on electronic and mechanical principles of operation: $5.

Jon Glazer
PO Box 31
Horse Creek, CA 96045

I/O Board (2401)

Designed for the Spectrum owner who wants to do I/O circuit design; 8 bit port; large prototyping area; description and application information on how to build multichannel sound generator. $29.95.

Elcomp
53 Redrock Ln.
Pomona, CA 91766
(714) 623-8314

FDZX1 Interface Board

Enables use of TS/ZX computers in automated measurement, data acquisition, instrument control applications. Fully buffered address, data, and control buses for I/O; 6 decoded device codes; 2 14-conductor, 6" cables to connect interface to other boards. Write for further information. Kit: $69.95; assembled: $99.95. $2 s&h. V/MC.

Group Technology, Ltd.
PO Box 87
Check, VA 24072
(703) 651-3153

Mathematics

Compu-Stat

General statistics program; calculates most descriptive statistics, graphs frequency distributions, and generates 3 tests of statistical inference; includes mean, median, 95 percent confidence limits, standard deviation, variance, range, high and low values, standard error of the mean, and (if more than one set of data) Student's t, Mann-Whitney U, or simple ANOVA. Manual and CC: $9.95.

Computercraft
156 Drakes Ln.
Summertown, TN 38483
(615) 984-3571

Multiple Linear Regression (S 026)

Computes correlation matrix, its inverse, regression coefficients, ANOVA, multiple R and coefficient of determination for up to 15 independent variables and 30 observations. Listing: $4 pp.; add $3 for CC. SASE for catalog.

Division Quiz (S 004)

Up to 25 random division problems. Maximum 4 digit divident; 3 digit divisor. Modification for changing skill. Listing: $2 pp.; add $3 for CC. SASE for catalog.

3 Factor ANOVA with Interaction (S 021)

Evaluates ANOVA where a single subject is exposed to one level for each factor; up to 5 levels of treatment per factor; up to 5 subjects per cell. 7 F-statistics are tested by an error term. Listing: $2.50 pp.; add $3 for CC. SASE for catalog.

Ako Tech, Dept. SL1
1613 Dayton Rd.
West Hyattsville, MD 20783

Electronics/Radio

Electronics

Use your computer in your electronics work: Ohm's law and power

dissipation, resistor/capacitor network calculations, astable/monstable "555" timer circuit, transistor amplifiers, power supplies, and other time consuming calculations. For free information write:
JPR Software, Inc.
PO Box 4155
Winter Park, FL 32793

Programming Aids

Toolkit
8 routines: Renumber, search and replace, search and list, free (bytes left); graphics: hyper-graphics mode, fill, reverse; tape routine.
JRS Software
19 Wayside Ave.
Worthing, BN13 3JU
U.K.

Step
Debugging tool for Basic programmers; provides single stepping through program lines or conditional or loop breakpoints; the Basic display and reports on up to 15 expressions are available after each step. MC; fits into upper 3K of 16K RAM. CC: $14.95.

Z-Tools
MC extension to Basic; allows you to: merge, renumber, copy or delete blocks of lines, verify tape against memory. 2 versions: upper 2K of 16K RAM and the 8-10K block of an expanded memory. CC: $14.95.
SINWare
Box 8032
Santa Fe, NM 87504

Graphics

Compu-Sketch (2K RAM)
Easily draw pictures of any sort on your screen. CC: $3; listing: $1.
Skelly Computer Programming
50 Riverside Dr., Camelot
Lake Placid, NY 12946

Graphics Drawer: $14.95; *Pixel Drawer:* $14.95.
New software line for the ZX/TS computers. 16K. Free 28 page catalog describes the line.
Dynacomp, Inc.
1427 Monroe Ave.
Rochester, NY 14618
(716) 442-8960

Hi Res Printer Graphics
Collection of MC utilities; 256 x 192 resolution on TS2040 or ZX Printer; includes plotting points, point to point line drawing, mixing hi-res and keyboard characters, full screen drawing. Reverse side: *LEASTHR:* weighted least squares linear regression analysis routine; outputs hi res straight line graphs calculated from x,y coordinates of data. CC: $10 pp.
Hi-Res Graphics Plans: Complete plans for building 256 x 192 hardware addition for hi-res display: $6.50 pp.
G. Russell Electronics
RD 1, Box 539
Centre Hall, PA 16828

Graphics Toolkit
23 routines including: DRAW, UNDRAW, FOREGROUND ON, FOREGROUND OFF, BORDER, UNBORDER, FILL, EDITPRINT, UPSCROLL, DOWNSCROLL, RIGHTSCROLL, LEFTSCROLL.
JRS Software
19 Wayside Ave.
Worthing, BN13 3JU U.K.

U.K. to U.S.

Quicksilva, Inc.
Quicksilva has set up a North American operation to market and manufacture its product line.
Quicksilva, Inc.
426 W. Nakoma
San Antonio, TX
(512) 492-8054

Downsway Electronics, Ltd.
Downsway has set up a new facility in Indio, Cal., to produce its computer products including software for the TS/ZX, Vic-20, and Commodore 64 computers, TS/ZX and Vic 20 RAM packs, the Jupiter Ace and accessories.
Downsway California Inc.
81824/D6 Trader Pl.
Indio, CA 92201
(619) 342-1223

Education Games/ Programs

Math Quiz
Quiz yourself in addition, subtraction, multiplication, and division. Three levels of difficulty. CC: $3; listing: $1.
Skelly Computer Programming
50 Riverside Dr., Camelot
Lake Placid, NY 12946

The Chemistry Tutor
Learn the more difficult concepts of introductory chemistry: writing chemical formulas, naming compound formulas, mole-gram-molecule conversion, balancing chemical equations, stoichiometry problems, gas equations. CC: $16.
H. R. Brady
301 Pine St.
Neptune Beach, FL 32233

Gradebook
Teacher's class records: alphabetize names; record exam, quiz, and other scores; assign weights to scores; statistical functions; curves; output to screen or printer. CC: $12.95. Sent Express Mail for $10 s&h.
Robotec, Inc.
59 C St.
Ampoint Industrial Park
Perrysburg, OH 43551

Astronomy

Ephemeris V

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Books

Introduction to Computer Programming (TS1000)
By Dr. Roger C. Palmer
Course notes developed *for UCLA Extension Course x414 for adult students without experience in computers or programming. Includes: Writing a program, program control (GOTO and FOR-NEXT); characters, codes, graphics; arrays; sorting; retrieval. 117 pp.; 8 1/2 x 11; $20 student ed.; $24 trade ed. with binder.
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Studio City, CA 91604
(213) 760-8110

The Elementary Timex Sinclair
Step-by-step chapters lead you through the process of hooking up the computer, loading and saving programs, creating graphics, music, and all kinds of utilities. By the time you are finished, you will be writing and using Basic programs. $14.95.
Datamost, Inc.
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(213) 709-1202

The Timex Sinclair Ideabook
By David H. Ahl
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Creative Computing Press
39 E. Hanover Ave.
Morris Plains, NJ 07950

The Microcomputer User's Book of Tape Recording
By Hilderbay, Ltd.
Tells how your tape system should work; how to choose a tape recorder, test and adjust it, keep it in good condition, select and care for tapes, make reliable recordings, load difficult tapes; how a tape recorder works. 60 pp. £2.90.
Hilderbay, Ltd.
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Solutions (1K RAM)
Solutions to the end-of-chapter exercises in *The Complete Sinclair ZX81 and Timex TS1000 Basic Course* published by Melbourne House. Hard copy program listings: $5.
Jack Carson
11200 Lockwood Dr., No. 307
Silver Spring, MD 20901

ZX81 Horizon
By Adrian Watney
Programming instructional book aimed at those ready to exploit the 16K RAM pack. 4 long programs with detailed analysis of how the lines and routines work. Programs on CC.
Uitgeverij Wolfkamp
POSTBUS 70254
(1007KG) Amsterdam
Netherlands

ZX81/Timex Programming in Basic and Machine Language
By Ekkehard Floegel
Programs listings and information. Chapters include: What is programming, programming in Basic and machine language, games, programs for school and data management, connection of a PIO, control programs, appendix. $9.95.
Elcomp Publishing, Inc.
53 Redrock Ln.
Pomona, CA 91766

Games

Headquarters
Navigate your space ship through the asteroids to find headquarters. CC: $3; listing: $1.
Skelly Computer Programming
50 Riverside Dr., Camelot
Lake Placid, NY 12946

Games *Megawurm*
Arcadelike game which exploits the graphics capabilities of the TS/ZX computers.

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Winter Park, FL 32793

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Demolition/Ten-Pin
Demolition: You must stop a moving wall before it reaches the top of the screen with carefully aimed bombs that destroy the wall piece by piece. Ten-Pin: Converts your computer to a bowling alley. Your score depends on how hard and accurately you send the ball down the alley.

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Reston Publishing Co.
TimeWare Marketing
11480 Sunset Hills Rd.
Reston, VA 22090
800-336-0338

Farmyard Flying
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Intercomputer, Inc.
PO Box 90, Prudential Center
Boston, MA 02199
(617) 437-1190

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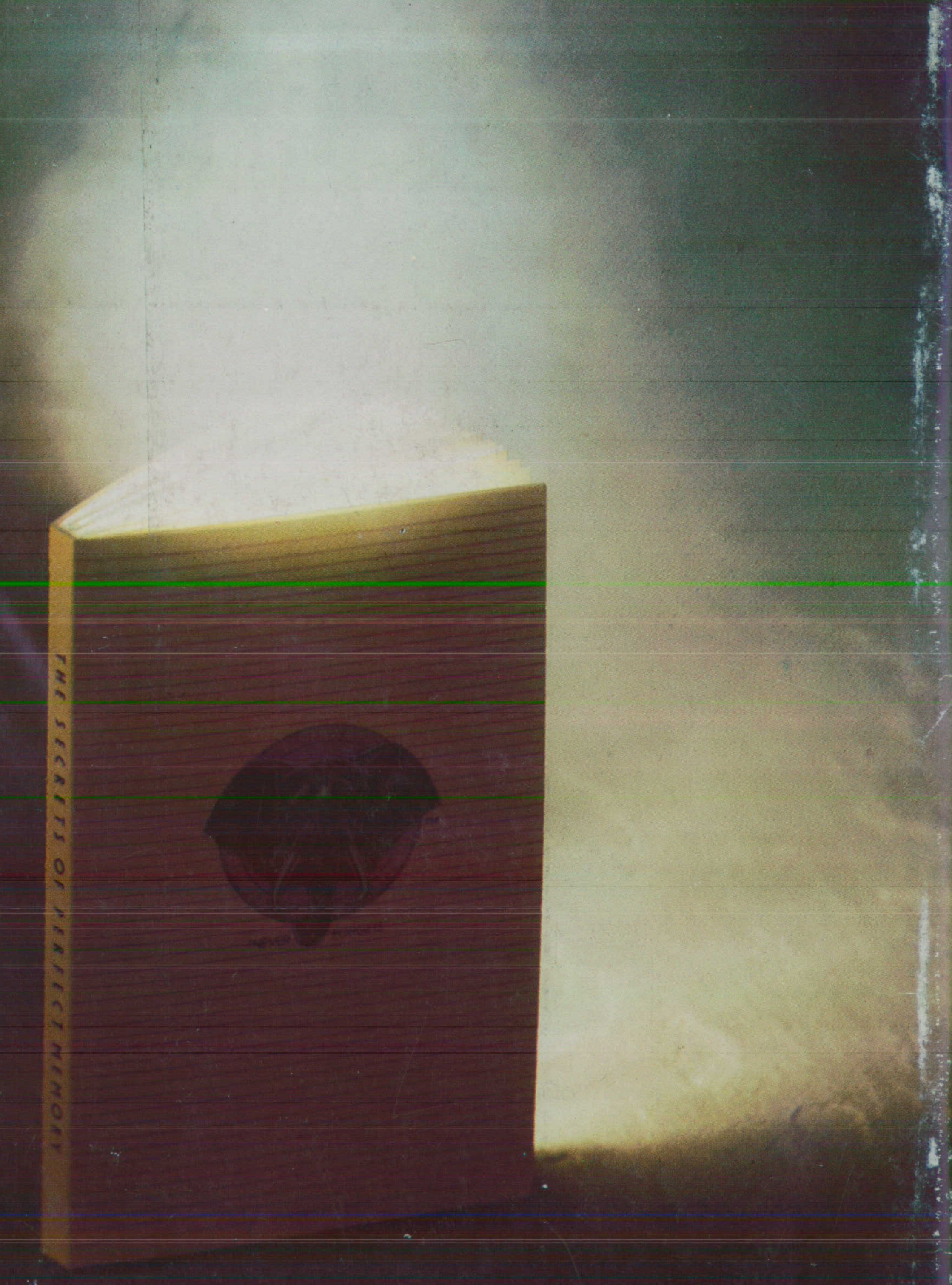

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